NATURAL SCIENCE:

A Monthly Review of Scientific Progress.

No. 18. Vol III. AUGUST, 1893.

NOTES AND COMMENTS.

The Exploration of East Africa.

AMONG the latest news of interest that reaches us this month is a communication from Dr. J. W. Gregory, giving a brief account of his expedition in East Africa up to the date of writing, May 8. It appears that he left Mombasa on April 23, taking with him a small force of only forty men, thus hoping the more easily and quickly to traverse any territory where food was scarce. He passed Kilwezi, the Nyika plateau, Nzoi, Kilungu, Zuni, Machakos, the Athi river, Lanjoro, and through the Kikuyu country to Fort Smith. His present letter reports very satisfactory, and is dated from Longenot, 450 miles from the coast, and to the north of Lake Naiwasha, Masailand.

Dr. Gregory has had little trouble with his men; there have not been any desertions; and food, though not abundant, was to be had; indeed, he says that on the banks of the Malewa he lived in luxury, game and birds being abundant, and a whole sheep costing less than a 2lb. tin of corned beef. There are no vegetables, except Indian corn and dry beans, of which he bought a ton at Fort Smith. His progress has been much delayed by heavy and persistent rains.

Dr. Gregory states that he has found *Senecio johnstoni* (a remarkable composite tree which attains a height of from 20 to 25 feet, previously recorded three times from Kilima-njaro, at heights over 8,500 feet) in considerable abundance near Naiwasha. His traverse of, and occasional branch excursions into, the Ulu Mountains have yielded considerable evidence with regard to the earth-movements of that district. He has found traces of the former existence of a vast lake to the south of Naiwasha, which was probably destroyed by the east and west line of elevation to which the volcanoes of Longenot and Kenia were due.

The hostility of the Masai, who happened to be on the war-path some 9,000 strong at Naiwasha, at the time of his visit there, compelled Dr. Gregory to leave that district more quickly than he wished, and this prevented him from making any examination of the lake fauna. He reports, however, that he found the site of a factory of stone implements used by some prehistoric tribe, and has traced one of their trade routes across a pass still used by some caravans. He expected to leave Lake Barengo (his farthest point) by the end of May, and to spend June and July exploring in the Aberdare Mountains, and on and around Mount Kenia. No further news can be expected of him until he reaches Brindisi on his return journey, about the end of September, for it is more than likely that he will miss the outward mail from Mombasa at the end of August. Save for a chill, caught while crossing a river, Dr. Gregory's health since he left the coast has been excellent.

"BORDERLAND."

MR. W. T. STEAD has sent us a circular containing information about his new Quarterly, *Borderland*, and a letter asking our views on the subject, as we are among those "whose opinion weighs much with the public," and from whom may be sought "such wise words of guidance in this new enterprise as he can collect from the most eminent of his fellow men."

It were easy to treat Mr. Stead's adventure with mere chaff or with ridicule. But Mr. Stead already has exploited the credulity of the public in the matter of red and blue electricity, and so competent a journalist doubtless will succeed in exploiting the superstitions of the class for which he caters. In this process it is "even money" that many will believe in the utility of his methods, while the odds are not long against his own belief in them. So he shall have our "wise words." He proposes to form a series of circles of students to study occult phenomena, and anyone may join a circle on payment of ten shillings per annum. The occult phenomena to be studied by this "veritable college of the occult sciences" are, we gather from the letter and circular, "the powers of the unconscious mind, multiple personality, invisible intelligences with whom we may profitably enter into communication, and the persistence of the individual after death."

These are questions of great interest, and the collection of data concerning them is of first-rate importance. But the evidence of those not trained to observe is misleading about the plainest occurrences: it will be absolutely worthless about phenomena so complicated by subjective and objective deception as these phenomena notoriously are. More than one expert in some science has been attracted to the investigation of spiritualism and has abandoned it, because of the ensnaring and degrading fraud associated with its votaries. And a college

chosen on Mr. Stead's plan will be a mixture of confiding simplicity and designing impudence. For the serious treatment of the obscurer questions of the mind there are in abundance laboratories of physiological psychology, trained specialists in the laboratories, and technical journals for the publication of their researches. The idea that science "has contemptuously relegated to superstition" such problems exists only in the minds of busybodies who have been snubbed. There are competent experts at work, and were the geologist to lay down his fossil and the anatomist his scalpel to follow Mr. Stead into the wilderness, they would aid only the wind to shake the reeds until such time as they turned to the stoning of the prophet who led them out. As for the "dangers" surrounding the study of occult science, let no fluttered neophyte be deceived. The dangers are real; though he will not be thrilled by any devil of his own raising, if the germs of imbecility lie in him they may well be scared into activity by the fraud of his associates.

Sierra Leone.

The Botany and Geology of Sierra Leone are the subject of a recently-issued Colonial report compiled by Mr. G. F. Scott Elliot, and embodying the results of his observations as botanist to the late Anglo-French Boundary Commission. Mr. Elliot has already laid before the Linnean Society the purely botanical results of the expedition, and in the present report, dealing with the economic aspect, has brought together a good deal of interesting and valuable information on the native or cultivated plants of the colony. A number of geological specimens have been named and described by Miss C. A. Raisin, of University College. The only mineral of importance is iron, of which the country apparently contains a very large amount. A specimen of titaniferous ore from a rich belt in the hills behind Sierra Leone, proved on analysis to contain 52 per cent. of the metal.

In speaking of the fertile alluvial soil along the coast and rivers, the effect of the mangroves in reclaiming land from the sea is described: "the trees seem, in fact, to have been designed by nature to change any bay or indentation of the coast-line into fertile soil." They require brackish water, and wherever a mudbank is in process of formation, there they grow, gradually advancing seawards as the silt accumulates. The trunk divides at the base into six or seven curved buttress-like roots, each of which by repeated sub-division covers a wide area with grasping supports. Moreover, from every branch long hanging roots descend vertically, dividing about the level of high tide into grasping fingers, which grow down into the water and take root so firmly in the silt that they cannot be torn up by any ordinary force of current. This meshwork of roots and rootlets catches and holds the fallen leaves of the mangroves, and all the

silt and soil in the water, and the accumulation rapidly advances. Gradually the level of the soil thus formed rises above high tide, and then the mangroves, which require a constant supply of brackish water, die off, and the whole grove advances seaward, leaving behind it a mass of rich vegetable alluvial mud, better suited for rice than probably any other soil in existence. Tobacco, sugar, and cotton would, doubtless, also do well. The part bordering the sea is adapted for the oil palm, and, presumably, also the coco-nut.

The rest of the country consists chiefly of low rolling hills or downs, covered by almost impenetrably thick bush 20 to 30 feet high, or tall grasses from 8 to 10 or even 15 feet. The upland plateaux, above 2,000 feet, would probably form excellent grazing ground.

Mr. Elliot concludes that, from a botanical point of view, the country is more suited to most valuable tropical plants than either Jamaica or Mauritius, but the climate is in most parts dangerous for Europeans, and neither energy nor physique can be kept up sufficiently to make proper use of its natural advantages.

Discovery of an American Type of Extinct Mammal in the Balkans.

As our palæontological readers are probably aware, those remarkable gigantic extinct Perissodactyle mammals known as the Titanotheriidæ (together with the Uintatheriidæ) have hitherto been regarded as confined to the Tertiaries of North America. Herr Vacek had, however, suggested, as far back as 1877, that a species from the Lower Tertiary of Transylvania, described under the neat and concise name of *Brachydiastematherium transilvanicum*, which has been generally regarded as a member of the Chalicotheriidæ, might really belong to the American family.

In a recently-published paper (*Sitzb. Akad. Wien*, 1892, pp. 608–615) Dr. F. Toula describes two mammalian teeth from Miocene beds at Kalina, near Sofia, in the Balkan Peninsula, which seem to leave no doubt that the family in question was really represented in the Tertiaries of Europe. The specimens consist of two very large lower molar teeth, which pertained, as shown by their different degrees of attrition, to as many individuals; one being the last and the other the penultimate of the series. That they belong to Perissodactyles there can be no question; and the last tooth differs from the corresponding molar of all the large Perissodactyles of Europe in possessing a third lobe, whereby it is at once distinguished from *Chalicotherium*. Dr. Toula refers the specimens provisionally to the American genus *Menodus*, under the name *M. rumelicus*,—a reference which we believe to be perfectly correct, save that the name ought to be *Titanotherium rumelicum*. He also supports the view that *Brachydiastematherium* is likewise a member of the same family.

We had been inclined to flatter ourselves that we were fairly well acquainted with the mammalian palæontology of Europe, and that there was not much hope of the discovery of any strikingly new types. However true (or false) this may be in regard to the mammals of Western Europe, it is quite certain that it will not hold good for those of Eastern Europe, where, doubtless, a large field awaits the investigator. That it is in this half of the Continent that American types would naturally be expected to occur, is self-evident, if the view that the migration from the one hemisphere to the other took place by way of Behring Strait be correct. The occurrence in Central Asia of deer closely allied to the Wapiti, and of an alligator whose nearest living ally is to be found in the Mississippi, are both strong evidences in favour of this view, which receives additional support from this new and most interesting discovery. We trust that ere long upper molars of the new fossil will be forthcoming, whereby its affinities may be more thoroughly indicated.

Plant Pitchers.

The recently-issued number of the *Annals of Botany* (June) contains two papers dealing with the pitchers of *Dischidia rafflesiana*, a twining epiphyte of the family Asclepiadaceæ, growing on trees in the forests of the Malay Archipelago. Mr. Groom has studied the live plants at Singapore, and also worked with spirit material in this country. Dr. Scott and Miss Sargant, the authors of the second paper, have had the advantage of living specimens now growing at Kew, sent two years ago from Java by Dr. Treub.

Study of the anatomical structure completely confirms Treub's view that the pitcher is a modified leaf, the upper surface of which grows more rapidly than the lower, so that the outer surface of the pitcher represents the upper surface of the leaf, and the inner surface of the pitcher the lower surface of the leaf. The mouth is small, with deeply incurved lips, and directed sometimes upwards, sometimes downwards. The stalk gives off roots which enter and ramify within the cavity, which contains a quantity of earthy particles, small stones, fragments of leaves, etc., and frequently water. Dead and decaying insects were also found in small quantity, and often ants, the latter sometimes abundantly. The first author thinks that the solids are mainly brought by ants, a view with which Mr. H. N. Ridley agrees, regarding them as the remains of ants' nests; having observed also that the earth in the pitchers resembles that at the foot of the host tree. As regards the function of these structures, Delpino's view—that the plant is carnivorous, the pitchers serving to catch insects, which are drowned, and then help to nourish the plant—meets with no support; as Treub has already objected, the roots afford a most convenient way of escape to any insects which might find their way into the cavity. There is, indeed, no provision either

for attracting or retaining insects, except, perhaps, the allurement of a shady resting-place; and Mr. Groom is inclined to lay stress on the last point, suggesting that the existence of species with merely concave leaves indicates the evolution in the pitcher of an organ more perfectly adapted to provide shelter for the ants on the one hand, and on the other to secure for the use of the plant the materials collected by them. At the same time, he recognises the function of storing up rain-water and the substances washed down therewith. Dr. Scott and Miss Sargant also attach considerable importance to the detritus in the pitchers, which is proved to serve as a food-supply. They, however, find no evidence of a myrmecophilous (ant-loving) habit, and agree with Treub that the detritus is washed in by the rain, the pitchers serving to collect rain-water, and in a less degree to economise the water of transpiration. The upright pitchers, they remark—those, namely, with the mouth at the base—"can have no other function than to store up the water given off as vapour in transpiration. We have shown, on anatomical evidence, that the inner surface of the pitcher is the chief transpiring surface of the plant. The condensed water of transpiration is undoubtedly re-absorbed by the roots." It is difficult to follow this last observation. A pitcher turned topsy-turvy could only store water in the reflexed rim, and as moisture clinging round the roots, which latter would doubtless be soon re-absorbed; but why should the vapour transpired condense to any appreciable amount within the pitcher? What plays the part of condenser? Surely the economy in water of transpiration is effected merely by the restriction of the area into which it is transpired, which, by becoming a still atmosphere saturated with water vapour, will retard further transpiration.

The same authors give an interesting account of the purple colouration on the inner surface of the pitcher, which contrasts strikingly with the pale green of the outer surface. Spectroscopic examination of the purple layer, also of an alcoholic extract of the pigment, showed a considerable absorption of the yellow and green, and almost complete absorption of the blue and violet rays. Hence the green and purple layers between them cut off almost all light from the interior of the pitcher, which thus forms a dark chamber, into which the negatively heliotropic root is likely to be attracted.

Fungus Parasitic on a Beetle.

Professor Alfred Giard contributes to the *Bulletin Scientifique* (vol. xxiv.) a study of *Isaria densa*, a fungus parasitic on *Melolontha vulgaris*, the cockchafer. He published two years ago in the *Comptes Rendus* a notice of this fungus, and the present essay is partly an amplification of it and partly a continuation of his experiences. This research has been inspired with the hope of waging a successful war,

in the interests of agriculture, on the cockchafer by wholesale infection of the larvæ with this fungus. Such methods have been tried, as everyone knows, by Continental mycologists and bacteriologists in certain cases, from the Australian rabbit downwards. In this country very little has been said or done, biologists being mindful, no doubt, of the luminous idea evolved by an eminent member of their body, and gravely proposed to his French colleagues, that they should exterminate the Phylloxera by means of the yeast fungus! No wonder if there has been a dearth of ideas on the subject in this country since then. M. Giard, however, has made a truly scientific study of the fungus and its artificial culture, and of the possibility of employing it in the manner indicated. It certainly deserves to be rewarded with a practical success. The great difficulty in the way of most cases of the kind is, of course, that which has at all times prevented the proper testing of the celebrated method of catching birds by putting salt on their tails. Every mycologist knows, however, the extraordinary powers of multiplication possessed by fungi, and the extraordinary diffusion of their spores. By assisting nature with artificial cultivations of the fungus, M. Giard has obtained a gratifying success so far as his proposal has been tested, and his method has plainly numerous advantages, as a natural and otherwise harmless one, over the usually futile one of sprinkling chemical insecticides. Such methods as M. Giard's deserve not only success but further developments, and it is to be hoped that they will not be hindered by vain talk of the dangers of "letting loose the germs of disease" generally indulged in by newspaper writers, who are willing to believe that one bacillus differs from another only in degree of rapacity in attacking the human body. To assist nature in such affairs is surely better than to squirt petroleum and other chemical (patent) insecticides over our gardens and fields. Some of these have a mischievous effect on the soil, and most have no measurable effect on the parasite; all are "quack medicines." For example, it was once proposed to cure the potato disease by the application of a substance costing about £17 per acre, as if this were the difference to the farmer between a good crop and a bad one of potatoes; moreover, the substance in question was useless for the purpose. Agriculturists should, therefore, welcome the development of all such rational proposals as this one of M. Giard, the fruit of much observation and ingenuity.

Algæ.

The second part of the *Phycological Memoirs* has just been published and amply fulfils the promise of the first number—indeed this part seems to us to be the more interesting of the two, dealing, as it does, with many of the vexed questions in the study of Algæ, which can only be settled satisfactorily in a place of such vast resource as the

British Museum. It is interesting to note that a letter confirming the results of the investigation of *Splachnidium* has been received by the authors of the new natural order, published in the last part. Mr. Laing writes from New Zealand describing the escape of the zoospores from the Splachnidian sporangia, which he has himself witnessed. The first paper in Part II. is entitled "Notes on the Morphology of the Fucaceæ" (*Coccophora* and *Seirococcus* by Miss A. L. Smith, *Notheia* by Miss Mitchell, *Xiphophora* by Miss Barton and *Sarcophycus* by Miss Whitting), and goes far to clear up points left undecided in this large and important order. It is prefaced by the editor, who explains that the authors of these notes have investigated material of genera unexamined or left uncertain by Oltmanns in his account of the Fucaceæ, and the result is in some ways confirmatory of Oltmanns' expectations. We are glad to see that the two genera *Ecklonia* and *Scaberia* are also to be examined, since the fact of finding oogonia on branched hairs in the female conceptacles of *Sarcophycus* would lead us to expect interesting results from the investigation of a genus so closely allied as *Ecklonia*. *Notheia* is also to receive more attention in a future number, since we have here an example of a degraded Fucaceous alga, if not a parasite, at least suspiciously attached to its host by a wedge of tissue like a haustorium.

A contribution by Miss Whitting on a new species of *Chlorocystis* shows careful investigation. The occurrence of parasites on Algæ is becoming a somewhat favourite field of research, and the new species here described is the only one of this genus which has hitherto been found to inflict injury on its host. It is a pity that this clever worker has not cultivated a more impersonal style of expressing herself. Possibly Mr. Bracebridge Wilson, who supplied the material to the British Museum, may be able eventually to report more completely on the life-history of this new parasite.

The editor (Mr. George Murray) has three papers—one throwing light on the much-disputed question of "fasergrübchen," or, as they are called here, cryptostomata. This, taken together with Miss Mitchell's paper on *Hydroclathrus*, places the character of these bodies in a clearer light than has hitherto been the case, and we hope Mr. Murray will not allow the matter to rest here, but will pursue the investigation still further and place the question of the real nature of cryptostomata beyond all dispute. His two remaining papers are, "On Halicystis and Valonia," and "A Comparison of the Marine Floras of the Warm Atlantic, the Indian Ocean, and the Cape of Good Hope." The former treats of *Halicystis ovalis*, Aresch.—a generic type new to Britain—and compares the morphology of this Siphoneous genus with that of *Valonia*. The remarkable reproductive organs of *Valonia*, noted in the living state some years ago by the author in the West Indies, are here described for the first time. Dr. Schmitz's remarks on the position of the genus *Halicystis* are incorporated in this paper.

In the comparison of the three Marine Floras, Mr. Murray is dealing with a subject on which he has already published several papers; and this one, embodying the results of a large amount of work, is a valuable contribution to a subject which has been very little studied.

The illustrations to this part of the *Phycological Memoirs* are equal to the last, and in both cases excellent.

We look forward to welcoming before very long the third part of this interesting book.

Popular Geology.

A SLANDER action of some interest has recently been tried in the Court of Session in Edinburgh. A County Council lecturer, Mr. Alexander-Johnstone, has been explaining the geology of soils to the "blameless Hyperboreans," and in the course of this, according to Sir Arthur Grant of Monymusk (defendant), he said certain wild and whirling things about the mistake of Providence in not putting more phosphates into the soil of Aberdeen, and made certain criticisms of the Biblical account of the Creation. The plaintiff denied having said such things, though he did say in reply to a question that he was not there to defend the first chapter of Genesis, and possibly he remarked that the account he would give of the creation of the world as proved by science might be more interesting than that given in the chapter referred to. Sir Arthur Grant had anyhow taken the occasion to reprove clergymen for quarrelling among themselves instead of uniting against men like plaintiff, and the Court seems to have agreed with him, and given him the verdict. We should greatly like to hear Mr. Johnstone's, or anyone else's account of the creation of the world "as proved by science." Sir Arthur Grant might then be shown as good sport by scientific men as any of the churchmen now militant in the north could exhibit. Such a match (Dr. Kinns on "Moses and Geology" barred, and Sir Henry Howorth, F.R.S., closured on the "Mammoth and the Flood") may be commended to the organising committees of sections in search of an exciting discussion for the British Association. It would be as seemly as a recent discussion on the Hygiene of Stays. So long as public lecturers regard the book of Genesis as the lamented Mr. Dick regarded King Charles I.'s head, they may expect a return innings, and it is to be deplored in any case that such matters should find their way into the Courts of Justice.

A correspondent sends us a newspaper-cutting containing a condensed report of this trial, with the remark that "if such bigotry and ignorance of geology prevails in Scotland, it is time some geological missionaries should enlighten the people." Our correspondent forgets that the countrymen of Hutton, Lyell, Murchison, the Geikies and others have already sent missionaries south in this matter, and they might do so again!

Dr. Herdman contributes to the *Conchologist* for June 24 an interesting confirmatory note as to the views of Giard with respect to the mimicry of the mollusc, *Lamellaria perspicua*. "The Mollusc," he says, "was on a colony of *Leptoclinum maculatum*, in which it had eaten a large hole. It lay in this cavity so as to be flush with the general surface; and its dorsal integument was not only whitish with small darker marks which exactly reproduced the appearance of the *Leptoclinum* surface with the ascidiozooids scattered over it, but there were also two large elliptical clear marks which looked like the large common cloacal apertures of the Ascidian colony." Professor Herdman did not notice the *Lamellaria* until he had by accident partly dislodged it in pricking the *Leptoclinum* from the stone. He points out that in this case we have the curious result that the *Leptoclinum*, while itself protected by sharp spicules against certain enemies, is thus armed to some extent for the benefit of the *Lamellaria* which preys upon its vitals.

We have received from Messrs. Hedley and Suter a copy of their "Reference List of the Land and Fresh-water Mollusca of New Zealand" (*Proc. Linn. Soc. N. S. Wales*, ser. 2, vol. vii., 1893, pp. 613–665), which enumerates no less than 184 species, as against the 15 first recorded by Gray in 1843. This jubilee list is therefore interesting in that it affords an index of the progress made in the study of an important section of Antipodean Malacology within half-a-century of its inception. The authors maintain that in proportion as the New Zealand fauna becomes known does its insularity stand out, and they enumerate no less than fourteen well-known molluscan genera which have been erroneously imposed upon it, though whether, as they say, *Helix* be one of them, very much depends upon whose classification of a very difficult group be followed.

Those interested in the microscopic details of the structure and contents of the plant-cell will find matter to their taste in the "Beiträge zur Morphologie u. Physiologie der Pflanzenzelle," edited by Dr. Zimmermann, of which the first volume has recently appeared. It includes, in 322 pages, fifteen separate communications, for twelve of which the editor is himself responsible. Among the items discussed are the internal structure of leucoplasts, which are not always homogeneous as hitherto supposed, but sometimes contain well-defined spherical bodies or *leucosomen*. Another body so far unrecorded, the *granula*, is found to be of widespread occurrence in the assimilating tissue of plants. The proteid-crystalloids, their detection, distribution, and properties, are dealt with in two of the longest papers, while the chromatophores of variegated and chlorotic leaves respectively form the subject of other two. As regards the last mentioned, the author

demonstrates the presence of small, colourless corpuscles in the leaves of plants which have had no iron salts in their food; on supplying an iron tincture the corpuscles grow and become green. There is also a short account of the properties, reactions, and distribution of the oil-plastid. Two papers refer to the growth of the cell-wall, and one, by C. Correns, is concerned with the internal structure of the cell-membrane of some Algæ. The last-named author also supplies an account of some points in the structure and life-history of a green resh-water alga, *Apiocystis Brauniana*, Naeg. The volume is well illustrated with five coloured plates and 23 figures in the text.

In the *Journal of Botany* for July, Mr. Rendle has a note on a potato which is depicted bringing forth young potatoes from its interior through clefts in the skin. The occurrence which, though previously described, has never been satisfactorily explained, is now said to be due to the production of shoots from the base of the bud or "eyes" as a result of the continued removal of the normal shoots. The tubers were stored in a cellar as usual, and the sprouts which appeared in the spring were plucked. In the case described the potato, perhaps an exceptionally vigorous one, devised a new means for using the large quantity of soluble nutrition which was being produced to supply the growing shoots, and as it was not allowed to form aërial shoots, developed from the base of the bud where the chemical processes would be specially active, tubercle-bearing shoots penetrating the substance of the mother tuber, and providing themselves with roots and a corky protecting covering in the same way as if they were pushing through the soil.

The writer refers to a similar physiological occurrence in the Mexican *Agave*. The Indians cut off the large spike-like terminal inflorescence at an early stage and then collect the sugary liquid which the plant continues to pour into the scooped-out top of the axis till it is exhausted, withers, and dies down. In both cases the chemical processes are suddenly rendered useless by removal of the organ for which the soluble nutrition was required; in both these processes continue, in the *Agave* for the gratification of the natives, whereas in the potato in question a new means for its use is devised. Of course, as the young tubers grow the mother shrivels proportionately, having to nourish its progeny from its own tissues.

We regret to observe that the editor of the *Journal of Botany* has taken to heart, as a serious criticism, a playful, but complimentary note on the abundance of cryptogamic papers in his pages, which appeared in Natural Science for June. It has, however, given him the opportunity of boasting the proud traditions of the *Journal* in the matter of fair play—a thing well-known to all botanists, but not made more savoury by an editorial announcement.

In a supplement to the *Leeward Islands Gazette*, Mr. C. A. Barber reports on the failure of the cacao crop in Dominica in the season of 1892–93. The failure is apparently not the result of any specific disease, but partly due to a reaction after a previous very successful season, and partly to a slovenliness in cultivation which is general in the island, and tends to induce an unhealthy tone in the trees, whereby the effect of climatic or unfavourable local influences is exaggerated.

Mr. H. O. Forbes' memoir on "The Chatham Islands: their Relation to a former Southern Continent," appeared last month, not in the Geographical Society's *Journal*, but in the *Supplementary Papers* of the same Society.

We understand that a shaft is to be sunk at the Dover Boring, at an estimated cost of £50,000. It was chiefly owing to the fact that the work was entirely under the control of Mr. Brady and Sir Edward Watkin that the boring was ever completed; it will be interesting now to see whether, under a board of directors, so much will be accomplished with so steady an end in view as was the work in which only two participated. Professor Boyd Dawkins is, we believe, one of the board.

We are glad to observe that our reference to the neglected state of the geological collection in the Museum of the University of Malta has attracted some attention in that benighted island. We may assure those interested that our information was not obtained from a resident, but from a geologist who is acquainted with most of the University collections of Europe, and who tells us that that of Malta was, five months ago, in a more disgraceful condition than any other he had visited. A correspondent, who states that he writes "officially," but at the same time requests that his name may not be divulged to anyone, points out that Mr. John H. Cooke is teacher of Mathematics and English in the Lyceum, not lecturer in the University.

The Geological Committee of Russia has just marked the completion of its first ten years' work by the issue of a geological map of the empire, produced chiefly under the direction of Drs. Karpinsky, Nikitin, Tschernyschew, Sokolow, and Michalski. The map bears 45 district notations, partly in colour, partly in signs, and the scale is about 40 miles to the inch. Much of the country is monotonous, being covered with post-Tertiary deposits, but the more striking features—such as the limit of extension of erratic blocks and the transgression of the old marine deposits in the Caspian region—are all duly indicated.

THE Geological Survey of Queensland has recently issued a report on "Geological Observations in British New Guinea in 1891," by A. Gibb Maitland, with three maps and two plates of sections. The formations now known are, besides coral reefs and surface deposits, the Post-Tertiary Kevori Grits, the supposed Tertiary Port Moresby Beds, and the Boioro Limestones of undetermined age, with metamorphic and igneous rocks. The coral rocks present no features of special interest. The Boioro Limestones are doubtfully placed beneath the Port Moresby Beds, and Mr. Maitland discovered no fossils; they sometimes contain flint nodules. Useful details are given, and the report concludes with a bibliography.

PALÆONTOLOGISTS will be glad to learn that Professor K. A. von Zittel has now completed his *Handbuch der Palæontologie*, and the last two parts will shortly be issued. His general account of the distribution of the extinct mammalia has just been published in advance in the *Sitzungsberichte* of the Bavarian Academy of Sciences, and a translation will shortly appear in the *Geological Magazine*. So valuable a comparison of the extinct mammalian faunas of different parts of the globe cannot fail to arouse a considerable amount of interest among those who have specially studied the subject of distribution; and the general survey now before us is one that has long been urgently required.

COMMENCING with the view that during the Secondary period the entire globe was inhabited by Multituberculates and Polyprotodont Marsupials, Dr. von Zittel considers that early in the Tertiary three great centres of mammalian development and dispersion were established. The centres in question were (1) Australia, (2) South America, and (3) Europe, Asia, Africa, and North America. Commenting on the alleged connection of South America, South Africa, and Australia by means of an Antarctic continent, he urges that had such connection taken place during the Tertiary period we ought surely to have found South American types of Edentates and Perissodactyles in Australia; and it must be confessed that those who urge the doctrine in question will have much difficulty in attempting to disprove the contention. At the same time, the evidence of the fossil Marsupials of Argentina shows that at some time there must have been a connection between the Australian and Neotropical faunas.

Special attention is directed in the memoir to the extinct faunas of Argentina and Patagonia, in the course of which it is shown that if the earliest of these be correctly assigned to the Eocene period, its mammals had attained a degree of specialisation far and away ahead of their North American and Old World contemporaries. All the

Ungulates, for instance, had attained tall-crowned or hypsodont molar teeth, and the same was the case with the Rodents, which had likewise discarded milk-teeth. Indeed, *Homalodontotherium* (we trust we have spelt the name correctly) is the only form which can be regarded as a generalised one; most of the Ungulates having the digits reduced to three, and the carpus of the interlocking type. The list of this earliest Santa Cruz fauna, as it is termed, includes only Marsupials, Edentates, Toxodonts, Typotherioids, certain aberrant and peculiar types of Perissodactyles, Hystricomorphous Rodents, and Primates allied to those now inhabiting South America; and the same holds good for the overlying Patagonian fauna, which has been correlated with the Miocene. All the genera found in these formations may accordingly be regarded as having originated in South America. When, however, we reach the still higher beds of Monte Hermoso and the Pampas, which have been identified with the Pliocene, we meet for the first time with Tapirs, Horses, Llamas, Deer, Mastodons, Murine Rodents, and true Carnivores, which are evidently immigrants from North America, where they occur in strata devoid of the remains of any of the above-named exclusively Neotropical forms. If further confirmation be required that the connection between the two halves of the continent did not take place before the Pliocene, it is forthcoming by the evidence of an incursion of South American Edentates into North America during that epoch. It may be added that the occurrence of monkeys belonging to the Cebidæ in the earlier Argentine Tertiaries affords some confirmation of the view that the monkeys of the Old and New Worlds have had an independent origin.

Palæontologists in the Argentine Republic have little opportunity for comparing their fossils with similar remains discovered elsewhere, and certain unfortunate rivalries have led to much confusion in the nomenclature even of the best-known genera and species. We are thus glad to announce that Mr. R. Lydekker, under the auspices of the Royal Society of London, leaves England on August 24, to examine the fossil vertebrata in the museums of Buenos Ayres and La Plata. He goes in response to the special invitation of Dr. F. P. Moreno, founder and director of the great museum in the new city of La Plata; and with his great experience of the Old World fossil vertebrata, he ought to render much service to Zoology by personally revising the work of his colleagues in the remote republic.

I.

Rainfall and the Forms of Leaves.

THE following notes are taken from an admirable paper by E. Stahl in the *Annales du Jardin Botanique de Buitenzorg*, vol. xi., pp. 98–182, on leaf-forms in relation to rainfall, chiefly based on observations of tropical plants at Buitenzorg. On arriving in Java (November, 1889), he was impressed with the great humidity of the atmosphere as well as with the extraordinary rainfall, and he was led to ask how the plants met such conditions. In the tropical forests they are not only subjected to daily thunder showers during the rainy season, but the sun's rays scarcely penetrate through the thick foliage, and the air is saturated with moisture which causes a perpetual drip from the leaves. An examination of desert forms, with their arrangements for economising their scanty water-supply, has thrown so much light on the peculiarities of certain plants of our temperate climates, that plant adaptations to opposite conditions on an equally large scale promised a rich and suggestive field of study.

Leaves, as we know, differ greatly in their behaviour towards atmospheric water; from waxy leaves the drops roll off, leaving no perceptible moisture behind, while other leaves, without this provision, tend to retain the moisture on the leaf-surface, and are weighed down and often broken off, in the tropics, by the added pressure on the brittle leaf stalk. The retention of moisture on the leaf after the rain is over interferes too with the transpiration, with which the rise of water in the stem with the supply of mineral salts to the growing and assimilating organs is connected. This function is provided for, and the difficulty so far met, by the great leaf-surface, but there are also various methods by which plants with easily moistened leaves dispose as speedily as may be of their superabundant water-supply. One of these methods is the adoption of the sleeping position by leaves, such as those of the sensitive plant, that possess this power of movement. Jungner,[1] a previous observer, says: "As soon as rain falls the horizontal leaves bend upwards as in the sleeping condition, and the rain-drops easily run off by the base of the leaf."

The most frequent way of disposing of the excessive moisture, however, is by draining it off by means of long points to the leaves.

[1] "Anpassungen der Pflanzen an das Klima in den Gegenden der regnerischen Kamerungebirge." *Botanisches Centralblatt*, 1891, p. 358.

These Stahl calls "*Träufelspitzen*," or dropping-points, and the rapidity with which tropical plants shed the rain-drops by this means is very astonishing. In a comparatively moist atmosphere, after a heavy rain, such plants as *Ficus acuminata*, *Angiopteris evecta*, and many others possessing *Träufelspitzen* had been long dry, while European or Australian forms with leaves ending in blunt tips, as the Oak, Apple, *Eucalyptus*, etc., yielded on shaking them a heavy shower of drops.

It is instructive to glance over any monograph of tropical genera and note the frequent use of the terms, "*folia longe acuminata*," "*folia acuminatissima*," "*folia caudata acuminata*." These *Träufelspitzen* occur also on the lobes of divided leaves, and on the pinnæ of compound leaves, but they are, perhaps, most remarkable on entire ovate leaves, such as those of *Ficus religiosa*, where the midrib grows out into a linear point sometimes 75 mm. long, the leaf itself measuring about 100 mm. from the stalk to the base of the point. In some plants the prolonged midrib of the leaf is a fairly wide channel, but the most ordinary form is that of a tapering narrow point slightly bent back and curved at the end, a peculiarity which is found in many European species. As the water trickles down the inclined narrow points, it passes from the upper to the under surface before dropping from the leaf, and the bent tip accelerates this action very distinctly.

Stahl tried several experiments to test this theory as to the advantage of *Träufelspitzen* to the plant. He took six leaves of *Justicia picta*, one of the Acanthaceæ, with leaf points a centimetre long, and slightly bent at the tip. From three of these the points were cut, and the ends carefully rounded; they were then fixed on a board, which was placed at an angle of 30 degrees, and sprinkled with water. The rounded leaves he found retained some of the moisture for an hour, the others were quite dry in 20 minutes or less. The same results were obtained with other similar leaves.

The veins of the leaf play a very important part in the drainage of water from the surface, especially when they are deep-seated, or, as in the Melastomacean type, where the parallel veins bend in towards the apex. In plants the leaves of which slant towards the stem, the water flows in a centripetal direction, and there we find such contrivances as the rows of hairs in the Bird's Eye (*Veronica chamædrys*), which act by capillarity like blotting paper, and draw away the water from the leaf-surface. Many plants with similar rows of hairs have also deep nerves and channelled stems, as the Blind Nettle (*Lamium album*), Hop, etc. Kerner, in his *Pflanzenleben*, vol. i., p. 85, discusses the importance to the plant of the direction in which the water is conveyed down by the leaves. He considers that it is directly related to the position of the roots, and that the object is to supply moisture to the young growing rootlets. But this seems hardly necessary in the case of tropical plants. It seems more probable that the advantage gained

by the leaf is, as already noted, the lightening of the weight, the aid to transpiration, and, lastly, the continual and thorough cleansing of the surface from insects, fungi, etc. We can verify this on our home plants. After a shower, the pointed leaves of ash, willow, etc., have had the dust quite washed off, while rounded leaves like those of the oak are still dirty. This cleansing of the leaves is of immense importance to tropical plants, as all will allow who have seen how they may become overgrown with hepatics, algæ, mosses, and lichens. These epiphytes, which have many contrivances to enable them to germinate and grow on the leaf, seriously interfere with its function, and we are justified in looking for arrangements by which the leaf will make it difficult for the epiphytes to get a footing. In the end they are generally successful, however, and the leaves with longest lives have the heaviest load to bear.

Plants with shining satin-like leaves, often tinged on the underside with red, form a great group much cultivated for the sake of the beautiful foliage. *Anthurium crystallinum*, *Philodendron Lindeni*, with begonias and many others, belong to this group. The peculiar brilliancy of the leaves is due to papillose outgrowths of the epidermal cells. These exert a capillary attraction on water, and the drops left after a rainfall are thus dispersed by the papillæ into a thin sheath which evaporates quickly and secures the rapid drying up of the leaf. This capillarity was tested by dipping the tip of a leaf of *Anthurium* in water, when the moisture was drawn up on the leaf 140 millimetres.

The long points to the leaves are certainly, in countries like West Java with a heavy rainfall, the chief means by which the plant disperses the excessive water-supply. In China and Japan, where the same conditions of humidity and great heat occur, they are a striking feature of the vegetation. An interesting exception is found in plants native to the drier regions along the shore or up on the mountains which have rounded or crenate leaves. In our own woods, while we occasionally find *Träufelspitzen* on the smaller herbs, as *Melampyrum sylvaticum* which has long tapering pointed leaves, they are very frequent on plants of a larger growth, especially on trees and shrubs that grow by preference in shady woods or along the banks of rivers, such as the ash and the willow; those that seek a drier soil, different kinds of *Prunus*, roses, etc., have no such provision. The same difference in structure appears in a more pronounced form when we compare the vegetation of different climates. In the Eastern United States, where great heat alternates with heavy thunder showers, there is a great abundance of tropical forms, much more so than in Central Europe where the summer is drier and colder; but even within the limits of the same genus, the American species have distinctly longer pointed leaves than their European relatives. In Europe, Stahl says, he noticed that longer points were developed on leaves in moist regions than where the ground and atmosphere were drier.

In further support of these observations, Stahl made a careful

examination of the leaf-forms of one or two very widely distributed genera. Quoting from Pax's monograph on the genus *Acer*, he presents to us first the species belonging to Europe: *Acer platanoides*, which in a wild state inhabits damp localities, and the Sycamore (*A. pseudo-platanus*) have pointed leaves; the Maple (*A. campestre*) grows on the plains and uplands of Central and Southern Europe, and the lobes of its leaves are blunt, as are those of *A. monspessulanum*, also from Southern Europe. In the United States and in Japan, the different species have leaves with long pointed lobes, and this feature is still more marked in the Himalayan varieties. *Acer integrifolia*, from Southern China and Japan, has a simple, entire leaf which ends in a long point. Though he does not (without other evidence) refer plants without *Träufelspitzen* to a dry climate, yet he concludes that when they possess this feature so strongly marked as in *Ficus religiosa* and others, they must grow in a country with a heavy rainfall. Stahl thinks also that this peculiarity, which is so entirely one of adaptation to climate, might throw some light on the conditions of growth of fossil plants.

In plants wholly confined to the tropics, many young leaves assume a hanging position on unfolding, and remain vertical for some days after attaining their full size. This is undoubtedly a protection from the heavy rain, and saves them from the devastation that overtakes so much of the vegetation in these destructive showers. When the leaves are stronger they become horizontal, though some very large leaves, as those of *Anthurium Veitchii*, remain vertical throughout their life. It would be interesting and useful to be able to calculate the exact force of the rain-drop as it strikes the leaf. This has not been worked out, but that the blow is heavy anyone knows who has been caught in one of these showers, or who has heard the noise made by the rain falling on palm leaves. Kny, in the *Berichte der deutschen botanischen Gesellschaft*, 1885, has directed attention to the danger incurred by leaves from rain and hail, and to the leaf-tissues and leaf-forms specially adapted to meet this emergency. In simple undivided leaves we find either great elasticity and bending power, or a strong leathery structure. In other leaves we have division into laminæ; either, as in many palm leaves, this takes place regularly by the splitting of a layer of cells as the leaf unfolds, or it is effected later by a tearing apart of the tissue. The division reaches its highest development when the laminæ are quite separate leaflets, as in most ferns and in many dicotyledonous plants.

The adaptation of leaf-form to function and environment is nowhere more strikingly seen than in those plants that at different times produce different kinds of leaves. The first leaf of the stately fern *Platycerium alcicorne* is unstalked and kidney-shaped, the mantle-leaf of Goebel,[2] and lies flat on the ground, thus protecting the young

[2] "Morphologische Studien.—I. Ueber epiphytische Farne u. Muscineen." *Annales du Jardin Botanique de Buitenzorg*, 1887.

roots from being dried up. The later leaves are erect and much divided. We find the same contrivance in one of the aroids, *Pothos aurea*, the stem of which is at first creeping, and bears flat sessile undivided leaves to protect the roots; when the stem ascends the leaves become stalked and pinnate. There are numerous examples of heterophylly among our European herbs; in many of the Compositæ, Cruciferæ, etc., the upright stalk bears linear, pinnate, or lobed leaves, while those forming the rosette of radical leaves are larger, and lie flat on the ground. Still another interesting point in leaf-adaptation is found in the nervature; either the nerves are parallel as in most monocotyledons, or they anastomose to form a network as in most dicotyledons. In the former case the leaf is simple, and of much stronger tissue; the complicated net-veining is found in wide-spreading leaves, and serves as a protection against splitting. In the Fern group the simpler type of parallel nervature prevails rather than the other, but during the Mesozoic age net-veined fern leaves were very abundant up to the close of the Chalk period. Then dicotyledons with leaves of a similar structure began to appear, and seem gradually to have taken their place.

Stahl closes the paper by a short examination of the leaf-tissues as they are affected by environment. In the long, slanting or bending leaves of monocotyledons the upright palisade cells of the assimilating tissue are replaced by cells the longest axis of which is parallel to the leaf-surface. By the massing of the strengthening elements towards the centre of the tissue, between the upper and under surface, the elasticity of the leaf is secured, and there is further provision against bending strains in those leaves with parallel veins, each of them being surrounded by strands of strong fibres.

ANNIE LORRAIN SMITH.

II.

On the Zoo-Geographical Areas of the World, illustrating the Distribution of Birds.

I HAVE been asked to tabulate the different regions, sub-regions, etc., of the world, of which I spoke, and which I illustrated in my recent course of lectures on the "Geographical Distribution of Birds" at the Royal Institution. I do this with some hesitation, because, as I explained in these lectures, our want of zoological statistics for vast tracts of the Old World makes it almost impossible to give exact definitions of the natural areas of any of the Palæogœan divisions of the globe.

With America it is different, as has been shown during the last few years by the admirable work of Dr. C. Hart Merriam and Mr. J. A. Allen on the distribution of North American Mammals, by means of which these authors have presented us with excellent maps defining the natural regions of the North American fauna. Mr. Allen has also recently published ("Auk," 1893, pp. 97–150 pls. iii., iv.) a separate paper on the zoo-geographical divisions of North America based upon the class Aves, and in my lectures I have followed the main conclusions of this paper, as I think it is better for ornithologists to adopt faunal regions based upon the distribution of *birds alone*, when we have some data to go upon. Until Mr. Allen published his avi-geographical maps, I was only too content to work by means of the maps furnished by Dr. Hart Merriam and himself from a study of the mammalia of North America, but I believe that we shall ultimately arrive at sounder conclusions with regard to the zoo-geographical divisions of the earth's surface, if each section of zoologists works out the statistics of his own branch, independently of those of other zoologists, so that at some future date the results can be correlated. This I can hardly expect to see accomplished in my day, but I hope that the present paper may be found to be a small contribution to this desirable result.

The American naturalists may well be envied for, and congratulated by their European colleagues on, the success which has resulted from their patient collection of materials. This has extended over many years, and now leaves them in the proud position of having better statistics to work upon than are possessed by the ornithologists

of any other portion of the globe, with the exception, perhaps, of our own islands.

While, therefore, many of my conclusions with regard to the extent of the provinces of the Old World must be purely conjectural from want of definite knowledge, there are certain sub-regions which may be suggested, and their boundaries defined, with some confidence.

Some of Mr. Allen's conclusions ("Auk," 1893, pp. 97–150) with regard to the main divisions of the Old World are the same as those of Dr. Reichenow, and I think that they are, in both instances, too sweeping; but the recognition and definition of an Arctic Zone or "Realm," as Mr. Allen calls it, is a fact which must henceforward be admitted by all ornithologists. Its southern boundary is probably along the isothermal line of 50° (mean summer temperature), and may be coincident with the northern limit of conifers.

Mr. Allen's "North Temperate Realm" includes both hemispheres to the northern border of the palm belt. Its southern line corresponds with the isotherm of 77° mean annual temperature, but this constitutes a very roughly defined southern border for the zoological areas of the Old World.

The southern border of palm-growth follows the southern isothermal line of 77° (mean annual temperature) but by no means defines natural borders for Mr. Allen's Indo-African Realm or Dr. Reichenow's Æthiopian and Malayan Regions, and it is better, as it seems to me, to stick to our old terms at present, instead of defining the limits of the Old World regions and sub-regions, with their ill-tabulated data, by analogy with the New World sub-regions, the boundaries of which are so much better known. It is for this reason also that I have not adopted Mr. Allen's nomenclature in its entirety. I may in due time be brought to speak of "Realms," but the same conservatism which prevents my adopting the trinomial nomenclature of the American zoologists of the present day, will prevent my discarding some of the old-fashioned, and, to me, expressive zoo-geographical terms. I cannot understand why the word "Nearctic" should be discarded. It was given by Dr. Sclater not in the sense of "arctic" but "northern" region of the New World, and is, in my opinion, apart from the priority which commands respect for its retention, a most simple and expressive term. My American colleagues will understand that if I have not carried their system of nomenclature into the zoo-geographical regions of the Old World, it is not from any want of respect to their work, for I heartily agree with their conclusions as regards North America; but a little time must elapse before we can confidently apply the same reasoning to the avifauna of the Old World. When Dr. Pleske and Professor Menzbier have finished their works on the birds of the Russian Empire, so that the confusion caused by the "lumping" tendencies of the Middendorffian school, so justly deplored by Dr. Stejneger, shall have been dispelled; when France, and Spain, and

Turkey, and Greece shall have been ornithologically explored and the results described in the complete American fashion; when the first collection of birds arrives from Timbuktu; when Arabia gives up its ornithological secrets; and when the parts of Siberia and Asia, of which nothing is yet known, have been explored; to say nothing of the high mountain interiors of many of the Malayan islands; then—and scarcely till then—shall we be able to generalise with some chance of success.

This deficiency in our information, however, need not prevent us from hazarding an idea—as has, indeed, often been done before now—of some of the avi-geographical regions of the Old World, and I place before my readers the divisions which I introduced into my Royal Institution lectures, leaving it for future statistics to confirm or destroy my conclusions. I begin, therefore, with the New World, adopting, for the purposes of my lectures, the old divisions of the Nearctic and Neotropical Regions:—

A.—Nearctic Region (Northern Region of the New World).

I. Arctic Sub-Region.
II. Alaskan Arctic Sub-Region.
III. Aleutian Sub-Region.
IV. Cold Temperate Sub-Region.
V. Warm Temperate Sub-Region.
1. Humid Province.
α. Appallachian Sub-Province.
β. Austroriparian Sub-Province.
2. Arid Province.
γ. Campestrian Sub-Province.
δ. Sonoran Sub-Province.

B.—Neotropical Region (Southern Region of the New World).

I. Antillean Sub-Region, including the Greater Antilles and Southern Florida, as also the Lesser Antilles, with the exception of Trinidad, Tobago, and the islands off the coast of Venezuela.

II. Central American Sub-Region.
1. Mexican Province.
2. Isthmian Province.

Until my friends, Messrs. Salvin and Godman, have finished their monumental "Biologia," it will be impossible to define accurately the boundaries of the several provinces, especially as fresh facts are being brought to light every day. A division may be hazarded on the lines of Mr. Salvin's conclusions published in the *Proceedings* of the Zoological Society for 1867 (pp. 131, 2) and 1870 (pp. 177, 8). Thus we shall probably get two provinces, which may be called:—

1. The *Mexican* Province, including Central America from Costa Rica northwards to Mexico, leaving out the Central Plateau,

which forms part of Mr. Allen's Sonoran Sub-Province. On the northern boundaries of the Mexican Province, Mr. Salvin's remarks ("Ibis," 1889, p. 242) must be consulted. On the eastern side it seems to follow the forests as they cling to the mountains almost to the Rio Grande, and the presence of Tinamous, Motmots, and Toucans mark the limit of the Neotropical Region. On the northern side the limits of the Mexican fauna are somewhat more extended and reach to about Alamos in Sonora.

2. The *Isthmian* Province, extending from Costa Rica to Panama.

For the rest of the Neotropical Region, I find that nothing can be proposed in modification of the four sub-regions proposed by Mr. Salvin, and published by Professor Newton in his article on Birds, in the "Encyclopædia Britannica." They are delineated in the accompanying map.

III. The Patagonian Sub-Region. This includes the southern portion of South America up to Bahia Blanca on the east coast, "thence in a north-easterly direction, passing to the eastward of Mendoza, and then northward along the eastern and higher slopes of the Andes, until it crosses the Equator, and after trifurcating on either side of the valleys of the Magdalena and its confluent the Cauca, returns along the western slopes of the lofty Cordillera, until it trends seaward and reaches the Pacific Coast of South America somewhere about Truxillo, in lat. 7° S." (*Cf.* Newton, *t.c.*, p. 744.) Mr. Salvin tells me that he considers that, besides the trifurcation of this region in Colombia above referred to, there are outlying portions of the same sub-region in the mountains of Santa Marta and Merida.

IV. The Brazilian Sub-Region. This "marches with the foregoing until somewhere near Potosi in Bolivia, whence it turns to the north-east, and, avoiding the water-shed of the Amazons, strikes, perhaps, the Paranahyba, through or along which it makes its way to the Atlantic." (*Cf.* Newton, *t.c.*, p. 744.)

V. The Amazonian Sub-Region limited to the southward by the Brazilian boundary, the western frontier of the Amazonian sub-region seems to turn off before the eastern confines of the Patagonian sub-region are reached, and, leaving a space intervening, it pursues a generally northward course, at a lower level, on the western bank of the Huallaga, and crossing the great stream, whence it derives its name, in somewhere about long. 77° W., lat. 5° S., it pursues its way towards the mouth of the Orinoco." (*Cf.* Newton, *t.c.*, p. 744.)

VI. The Sub-Andean Sub-Region. "This begins in the south with a narrow strip of land, before mentioned as intervening between the comparatively low-lying Amazonian sub-region and that portion of the Patagonian which runs along the lofty Peruvian Andes, and is believed to extend from the frontiers of Bolivia to the table-land of Ecuador, rounding, on the one hand, the forked extremity of the Patagonian sub-region to the westwards until it meets the Pacific at Truxillo, stretching over five hundred miles of sea to the Gala-

pagos Islands, following the Amazonian boundary to the Atlantic, while it comprehends the islands of Trinidad and Tobago, as well as those which lie on the northern coast of South America." (*Cf.* Newton, *t.c.*, p. 744.)

C.—The Palæarctic Region.

This may be divided roughly into three sub-regions, besides the

Arctic Zone,

which corresponds with the same zone in the New World, and becomes a circumpolar province. The greater part of the northern Palæarctic Region may be denominated the

I. Eurasian Sub-Region,

while the southern portion forms another sub-region, which may be called the

II. Mediterraneo-Asiatic Sub-Region;

the one answering to Mr. Allen's "Cold Temperate Sub-Region," and the other to his "Warm Temperate Sub-Region."

A very good idea of the limits of the breeding areas of the Western European birds has lately been given by Mr. Henry Seebohm in his most useful introduction to his "Geographical Distribution of British Birds," and on discussing with him the natural geographical divisions of the European Avifauna, he suggests that the Scandinavian mountains must form part of the Arctic Zone which should extend as far south as the Dooreſjeld, and this would correspond with the breeding range of several Arctic species, such as the Snowy Owl, &c. The Yenesei Valley, as Mr. Seebohm has before pointed out, is the natural boundary between the Eastern and Western Palæarctic birds, the Urals being by no means a strong natural boundary. Mr. Seebohm deprecates the division of the Eurasian Sub-Region into provinces, and I admit that, with the data at present in our hands, it is difficult to define the limits of natural provinces, but I expect that we shall ultimately have to recognise a Central Siberian, as well as an Eastern Siberian province. The former will be the breeding home of such representative forms as *Motacilla beema* instead of *M. flava*, *Corone sharpii* instead of *C. cornix*, *Sturnus menzbieri* instead of *S. vulgaris*, etc., while the Eastern Siberian Province will probably extend from the water-shed of the Lena to Kamtschatka. It will contain the breeding home of *Eurinorhynchus pygmæus*. Dr. Stejneger advocates the recognition of a distinct Kamtschatkan province. On this and other points connected with the distribution of Western Palæarctic birds, his admirable paper must be consulted (*Bull. U.S. Nat. Mus.*, no. 28). As in the case of the Palæarctic Region itself, the provinces will not be found to contain different families or genera, but will be characterised by representative species alone.

The following will, therefore, probably be found to be the natural areas of the Palæarctic Region:—

I. The Eurasian Sub-Region—
   1. European Province—east to the river Ob.
   2. Central Siberian Province. Between the Ob and the Lena.
   3. West Siberian Province. From the Lena to the Pacific.

II. The Mediterraneo-Asiatic Sub-Region—
   1. Mediterranean Province.
   2. Mediterraneo-Persic Province.
   3. Mongolian Province.

III. Mantchurian Sub-Region.

There is also another natural sub-region, which I propose to call:—

IV. The Himalo-Caucasian Sub-Region.

It consists of the highest Himalayas from 8,000–10,000 feet (ex. *Tetraogallus*), the mountains of Tibet and the Altai to the north, and westwards through the mountains of Persia to the Caucasus and the hill-country of Asia Minor.

The Mediterraneo-Asiatic Sub-Region has at least three distinct provinces with characteristic forms, as was shown by Mr. H. J. Elwes in his celebrated essay (*Q.Z.S.*, 1867, pp. 645–682):—

1. The Mediterranean Province.
2. The Mediterraneo-Persic Province.
3. The Mongolian Province.

The Mantchurian Sub-Region reaching from Eastern Siberia, south of the Stanovoi Mountains, west to Lake Baikal and south to the Yangtze basin, appears to me to be established by statistics. It contains a strong Indian element, with such species as *Eurystomus calonyx*, *Halcyon pileata*, *Hirundo tytleri*, *Pericrocotus*, *Suthora*, etc., and is further characterised by several eastern representative species of well-known western forms, such as *Trypanocorax pastinator* for *T. frugilegus*, *Colæus dauricus* for *C. monedula*, etc.

D.—The Ethiopian Region.

Of the Ethiopian Region it is only necessary to remark that I have greatly modified my views since I proposed zoo-geographical sub-regions of Africa in 1870. The great desert of the Sahara still remains a blank to us and may be called

I.—The Saharan Sub-Region,

but I have come to the conclusion that a second large natural sub-region can be admitted which I call

II.—The Sudanese Sub-Region.

The number of species which are common to Senegambia and to Abyssinia and Kordofan, proclaims that there must be a natural zoo-geographical sub-region stretching across between these two distant areas. Its northern and southern boundaries cannot yet be defined, but it is a somewhat important fact that a truly Sudanese form like *Melierax polyzonus* has been found in Mogador

and Southern Morocco. The Delta of Egypt must be included in the Mediterranean Region, and I am not able to define the exact boundary of my Sudanese Sub-Region in the north-east. The occurrence of a *Centropus* in the Delta shows the presence of an African element even in Lower Egypt, but the regional boundary may be about the second Cataract, above which no Sun-birds (Nectariniidæ) are found.

III.—The West African Sub-Region.

This might well be called the "Afro-Malayan" Sub-Region, as it possesses species of *Turdinus*, a *Pitta*, some Diceidæ, and other curious forms which are Malayan in their affinities. It consists of the forest districts of Southern Senegambia, and embraces the whole of the West African forest region from the above-mentioned point to the Kwanza River, its continuity being broken at Accra, where the Sudanese Sub-Region breaks through to the coast with its attendant Bustards (*Otides*) and Hemipodes, and this will probably be found to be the case at other intervals of the coast-line. The forest region may also extend a little way across the Kwanza into the interior of Benguela. Certainly it embraces the whole of the Congo basin as far as the western water-shed of the Nile, as was shown by Bohndorff's collection from the Niam Niam country and by many species obtained by Heuglin and Emin Pasha in the Equatorial Province.

IV.—The Abyssinian Sub-Region, consisting of Abyssinia and Southern Arabia.

This not only embraces all the area which I assigned to it in 1870, but must be carried north of the Zambesi, recent explorations having shown that I was mistaken in believing the latter river to be a natural boundary. It may even be found to stretch, in a broken and disjointed manner, far into Equatorial Africa, as proved by the discovery of *Chera progne* and *Pyromelana taha* by Mr. Jackson in Equatorial Africa.

V.—The East African Region.

This is not a very natural sub-region, and may have to be sunk in one of the others; but at present such a number of forms seem to be peculiar to it that it is best to recognise it till our present knowledge of the East African avifauna has been tabulated and brought up to date.

The South African Sub-Region.

It is to be noticed that in the map I have indicated the existence of a

1.—Cape Province.

By this I intend the Cape Colony south of the Karroo and reaching eastwards to the neighbourhood of Port Elizabeth and East London. Quite a number of distinct forms inhabit this province.

2.—The Natalese Province.

There is another province, which commences, probably, in British Caffraria, certainly about the Berea, near Durban, and extends along the Drakensburg mountains, including the forest regions of the Transvaal, such as the Lydenburg district, and reaches the Zambesi, whence I believe it will be found to stretch across to Benguela and Angola.

Lastly, I propose to recognise a

V.—Victorian[1] or Camaroonian Sub-Region,

consisting of the elevated mountains of Central East Africa, and extending from the highlands of the Lake Regions across to the peaks of the Camaroons. This is a natural sub-region and is characterised by a number of forms. The recent collections sent home by Mr. H. H. Johnston, C.B., show that this mountain fauna extends to the Shirè Highlands, as is evidenced by the presence of *Cryptospiza* and the inevitable green *Xenocichlæ*, which we now look for at a certain elevation, and which are known from the Shirè Mountains, Kilimanjaro, Elgon, and the Camaroons. The occurrence of many peculiar species and genera such as *Pædilorhynchus* in the Uganda Highlands, and again in the Camaroon Peaks, shows that there is a close connection between the Avifaunæ of these elevated mountains, and, doubtless, Kenia and Ruwenzori will be found to belong to the same system. The highlands of Shoa certainly belong to it, and some of the Abyssinian mountains will also, in all probability, have to be included.

VI.—Lemurian or Mascarene Sub-Region, consisting of Madagascar and Adjacent Islands.

E.—Indian Region.

This follows the usual boundaries laid down by Dr. Sclater and Dr. Wallace. The division of the Indian Peninsula into provinces will probably be determined by the mean annual distribution of rainfall, as shown by Mr. Hume in his interesting paper ("Stray Feathers," vol. vii., pp. 501, 502). This paper has not received half the attention which it deserves, and many of the problems connected with the presence of a Malayan element in the western portion of the peninsula and the mountains of Southern Ceylon become less difficult of comprehension when we find that they belong to countries where the rainfall is 70 inches and upwards. In the Himalayas we have apparently the foci of three separate sub-regions; there is a strong Palæarctic element illustrated by the number of species of *Carpodacus*, *Pyrrhula*, etc. There are also recognisable two more sub-regions.

Another Sub-Region would be

The Himalo-Chinese Sub-Region, somewhat as defined by Mr. H. J. Elwes, and illustrated by such forms as *Polyplectron*; while a third

[1] Not named directly in honour of Her Most Gracious Majesty, but intended to show that Mount Victoria in the Camaroons, and the Victoria Lake country in Equatorial Africa, belong to the same natural sub-region.

natural sub-region seems to be the Himalo-Malayan Sub-Region, which includes the high mountains of Burma, the Malayan Peninsula, Sumatra, Java, and Borneo. A representative form would be *Psarisomus*. The Indian Region would, therefore, be divided as follows:—

1. Indian Peninsular Sub-Region.
2. Indo-Malayan Sub-Region.
3. Indo-Chinese Sub-Region.
4. Himalo-Malayan Sub-Region.
5. Himalo-Chinese Sub-Region. The high mountain portion of the Indo-Chinese Sub-Region.

In the Australian Region, east of Wallace's line, I think that the following sub-regions can be fairly well recognised:—

I. Celebean Sub-Region.
II. Moluccan Sub-Region.
III. Papuan Sub-Region, which should include North Eastern Australia with its *Casuarius* and *Tanysiptera*.
IV. Australian Sub-Region.
V. New Zealand Sub-Region.
VI. Fijian Sub-Region.
VII. Hawaiian Sub-Region.

R. Bowdler Sharpe.

To face Page 168.

ZOOGEOGRAPHICAL AREAS

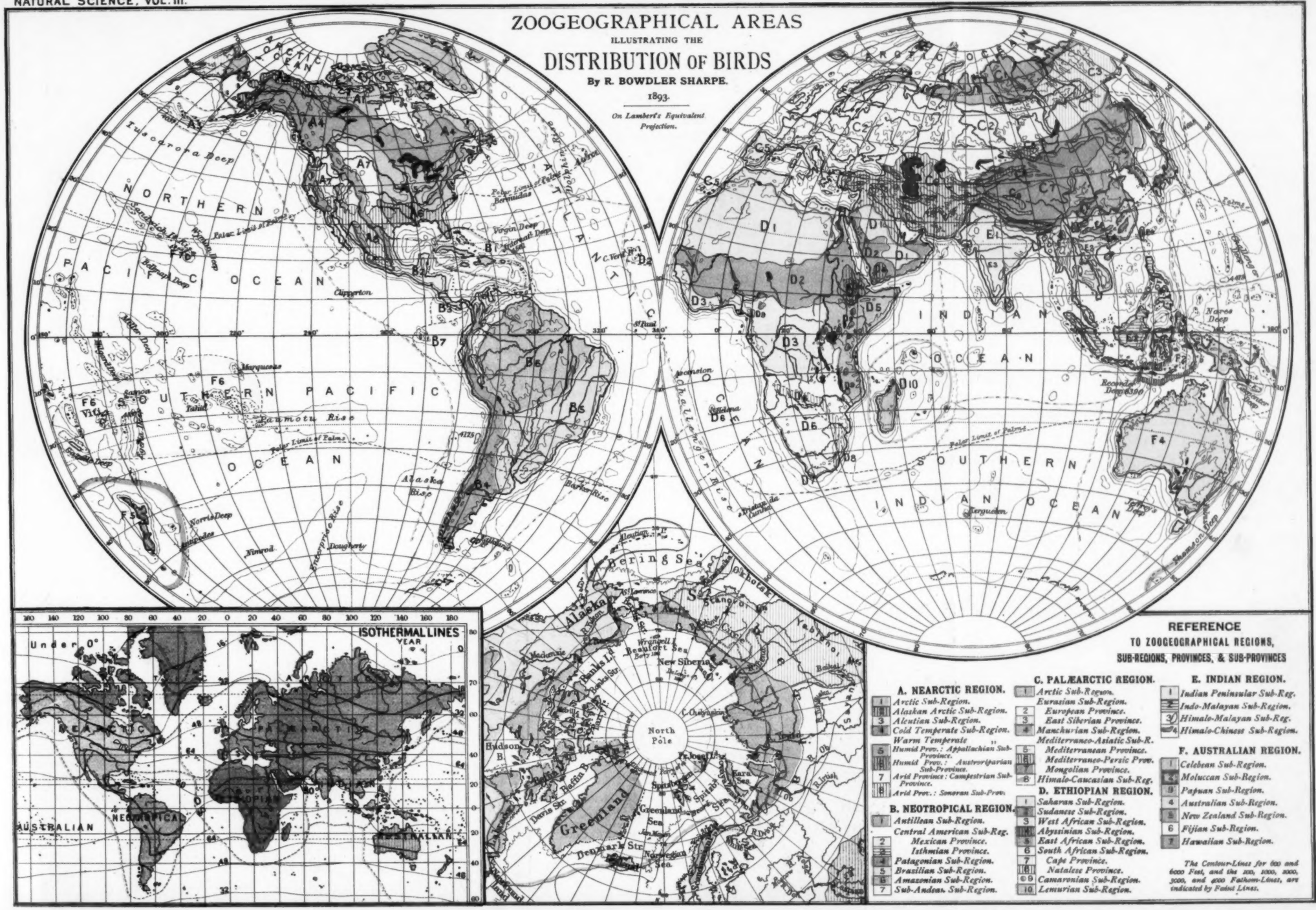
ILLUSTRATING THE

DISTRIBUTION OF BIRDS

By R. BOWDLER SHARPE.

1893.

On Lambert's Equivalent Projection.



REFERENCE

TO ZOOGEOGRAPHICAL REGIONS, SUB-REGIONS, PROVINCES, & SUB-PROVINCES

A. NEARCTIC REGION.

- I. *Arctic Sub-Region.*
- II. *Alaskan Arctic Sub-Region.*
- 3 *Aleutian Sub-Region.*
- 4 *Cold Temperate Sub-Region.*
- *Warm Temperate ,,*
- 5 *Humid Prov.: Appalachian Sub-Province.*
- III. *Humid Prov.: Austroriparian Sub-Province.*
- 7 *Arid Province: Campestrian Sub-Province.*
- 8 *Arid Prov.: Sonoran Sub-Prov.*

B. NEOTROPICAL REGION.

- I. *Antillean Sub-Region.*
- *Central American Sub-Reg.*
- 2 *Mexican Province.*
- 3 *Isthmian Province.*
- 4 *Patagonian Sub-Region.*
- 5 *Brazilian Sub-Region.*
- 6 *Amazonian Sub-Region.*
- 7 *Sub-Andean Sub-Region.*

C. PALÆARCTIC REGION.

- I. *Arctic Sub-Region.*
- *Eurasian Sub-Region.*
- 2 *European Province.*
- 3 *East Siberian Province.*
- 4 *Manchurian Sub-Region.*
- *Mediterraneo-Asiatic Sub-R.*
- 5 *Mediterranean Province.*
- III. *Mediterranco-Persic Prov.*
- 7 *Mongolian Province.*
- 8 *Himalo-Caucasian Sub-Reg.*

D. ETHIOPIAN REGION.

- I. *Saharan Sub-Region.*
- II. *Sudanese Sub-Region.*
- 3 *West African Sub-Region.*
- IV. *Abyssinian Sub-Region.*
- 5 *East African Sub-Region.*
- 6 *South African Sub-Region.*
- 7 *Cape Province.*
- VIII. *Natalese Province.*
- 9 *Camaronian Sub-Region.*
- 10 *Lemurian Sub-Region.*

E. INDIAN REGION.

- I. *Indian Peninsular Sub-Reg.*
- II. *Indo-Malayan Sub-Region.*
- III. *Himalo-Malayan Sub-Reg.*
- IV. *Himalo-Chinese Sub-Region.*

F. AUSTRALIAN REGION.

- I. *Celebean Sub-Region.*
- II. *Moluccan Sub-Region.*
- 3 *Papuan Sub-Region.*
- 4 *Australian Sub-Region.*
- 5 *New Zealand Sub-Region.*
- 6 *Fijian Sub-Region.*
- 7 *Hawaiian Sub-Region.*

The Contour-Lines for 600 and 6000 Feet, and the 100, 1000, 2000, 3000, and 4000 Fathom-Lines, are indicated by Dotted Lines.

UNIV. OF MICH.

III.

Earthworms and the Earth's History.

THERE has been recently a considerable discussion in the pages of *Nature* as to the probability of a former extension northwards of the antarctic continent. The discussion has also affected the columns of this Journal, which published last month an abstract of the recent views of Mr. H. O. Forbes on the subject. Mr. Forbes believes in this continent. We quite agree with him, though for reasons different to those which he urges.

It seems to be an obvious platitude that those animals are most important for use in arguments relating to the past connection of land masses which do not migrate of their own free will across the sea, and are incapable of being carried over by accidental modes of transit, and yet, with one exception to be mentioned presently, the group of all others which best fulfils these conditions has been completely ignored by writers on the subject of geographical distribution. The group to which we refer is that of the earthworms.

The earthworm, like the agricultural labourer, is wedded to the soil; more so, indeed, for the labourer does occasionally emigrate, but the earthworm never, and for the very good reason that sea-water is fatal to his constitution. Although earthworms do not apparently ever cross the sea by any of those modes of transit which are held to account for the range of other animals, there is sometimes (again like the agricultural labourer) "assisted emigration." Commerce between different countries is apparently responsible for the transference of earthworms from one country to another—particularly, of course, the exportation and importation of plants. That this is really the case is capable of the easiest proof; any collection of living plants from a foreign country is nearly sure to contain a few worms, besides, of course, insects and other small creatures. Indirect but still convincing proof of man's agency in affecting the distribution of earthworms is shown by the wide range of the common earthworms of Europe which belong to the genera *Lumbricus* and *Allolobophora*. In Europe and North America these two genera are the prevailing types, to the nearly complete exclusion of any others. In such distant and widely-separated regions as New Zealand and South America, the same genera are met with, but they are not the prevailing types.

Now, there is not, so far as I am aware, a single exception to

the truth of the statement that in all these cases the foreign species are identical with those found in Europe and North America. Were the forms in question really indigenous, different species, or at the very least, varieties might be fairly expected to occur; but they do not occur. Any difficulties in the existing distribution of animals are apt to be explained in one or two ways; either a continent is evoked from the vasty deep for this occasion only, or tree trunks and floating *débris* are pressed into the service. As has been already mentioned, earthworms are killed by salt water; so that we must assume a former land connection to explain their presence on both sides of a strait of whatever width. It is a most remarkable fact that works dealing with geographical distribution and the geological arguments to be derived from a study of animal distribution have not made use of this important material; the only paper known to us which does make use of this group is by Professor Spencer on the fauna of Tasmania (*Australasian Assoc. Adv. Science*, Presidential Address, Section D, 1892). Other terrestrial invertebrates are doubtless of use; but up to the present, hardly anything except insects and land shells have been studied from this point of view. But in neither of these groups are the anatomical relations between the genera and species so clear as might be wished. This partly destroys their value, as does also the fact that they possess facilities for migration, passive or active, not possessed by the earthworm. Sealed up in its shell by the temporary operculum, a snail is capable of extended travel; butterflies can, as we know, fly for long distances; the earthworm has none of these advantages; the cocoons might, it is true, be conveyed on the feet of birds, but they are often below the soil, sometimes very far down; this mode of transit has very possibly occurred in the case of the aquatic worms allied to the earthworm, which deposit their cocoons at the margins of streams and rivers frequented by birds; in this way we may possibly account for the wide prevalence of the common "red-worm" of our rivers (*Tubifex rivulorum*).

Applying these facts to the particular case in question, it seems to us that the former existence of a southern continent is rendered at least very probable. The earthworm fauna of New Zealand, which is fairly well known at present, is characterised by the presence of the genus *Acanthodrilus*, this genus and its immediate allies forming nearly the whole of the indigenous earthworm fauna of the country. Australia, on the other hand, is characterised by quite a different family, the Cryptodrilidæ, comprising three or four genera, perhaps more; *Acanthodrilus* is represented by only two species, which are found upon that side which is believed to have had, at a remote period, a connection with New Zealand. The Australian family is, on the other hand, only represented by two or three species in New Zealand. The genus *Acanthodrilus* (using the genus in its widest sense) is also characteristic of Patagonia and South Georgia (so far as is known), and the more southern parts of South America. The

only worms known from Kerguelen and from Marion Island are members of the same genus. "Ethiopian" Africa has many species of the family which differ more from those of New Zealand than the latter do from those of Patagonia—in fact, they have been placed in a separate genus, *Benhamia*; a few members of the same genus or subgenus occur in the West Indies and one or two in India and Malaya. It is only, however, in Patagonia and New Zealand that this genus is the prevailing one; in the other countries mentioned it occurs, but there are numerous other and more abundant forms. The important point to be noticed is that, as we pass northward from the antarctic region, this particular genus thins out, until in the continents of Europe and Asia it is hardly to be found.

The former existence of a habitable antarctic continent with arms stretching to New Zealand, Africa, and Patagonia seems to be the clearest way of explaining these facts.

F. E. Beddard.

IV.

Some Useful Methods in Microscopy.

HAVING been occupied during the spring of 1892 in studying the early stages in the development of *Loligo* and *Sepia* at Naples, I found myself unable to make any progress in solving the problems presented by these difficult objects until I had obtained a satisfactory method of preparing and mounting blastoderms, quite freed from yolk, for study of surface-views under the microscope. After trying many methods, I at last hit upon one which, while exceedingly simple in application, not only gave the most beautiful results for these blastoderms, but has also proved applicable for other objects which are not more than a few cell-layers in thickness, such as early chick embryos, and still more so, of course, for unicellular objects, such as Protozoa. It seemed to me, therefore, desirable to describe briefly the methods employed by me, since they may prove useful to other zoologists. In so doing, however, I do not in any way wish to lay claim to any originality or precedence in inventing them. For all I know they may have been already described by many other investigators. Wherever I give any method which I have obtained from an author I shall give the reference to him; where I do not do so, my apparent oversight is to be set down to my ignorance of the now vast literature of the subject.

The method employed by me for cephalopod blastoderms is exceedingly simple in principle, though its mode of application varies, of course, with the nature of the object, and may require a high degree of manual skill, to be obtained only by much practice. It is as follows. The fresh objects are first brought into Hermann's fluid for a short time, until all the cells are fixed; this is, as a rule, effected in 2–5 minutes, but the proper length of exposure to the action of the reagent can best be determined by the eye; as soon as the cells become white and opaque they are sufficiently fixed. Too long exposure is injurious to subsequent staining.

After the Hermann's fluid, the objects are carefully washed in two or three changes of water to extract all the reagent. This also is an important point for staining. After washing, the objects come into either alum carmine or Paul Mayer's[1] newly invented stain carm-alum.

[1] "Ueber das Färben mit Carmin, Cochenille, und Hämatein-Thonerde." *Mitth. Zool. Stat. Neapel.* Bd. x., Heft. 3, p. 489.

Here they are left for an hour or two until completely stained. They are then washed with water and brought up through the alcohols—30 %, 50 %, 70 %, 90 %, and absolute—into oil of cloves, and then mounted in Canada balsam.

The above is the complete plan of procedure for this method. Before, however, proceeding to describe its practical application to the objects in question, a few words are necessary concerning the agents mentioned.

Hermann's fluid was, as its name implies, invented by Hermann[2] in his studies on nuclear division, etc., in the testis. It may be described as a paraphrase, so to speak, of the well-known Flemming's fluid (the second or strong solution) in which the 1 per cent. chromic acid is replaced by 1 per cent. platinum chloride, thus:—

Platinum chloride 1 per cent.	15 parts.
Osmic acid 2 per cent.	4 ,,
Glacial acetic	1 part.

I always make it up according to the following recipe:—Take one of the ordinary sealed glass tubes containing a gramme of osmic, as it is commonly sold, and break it in a bottle of a capacity of about 300 cc.; then pour on it 50 cc. of pure distilled water, 12·5 cc. of glacial acetic, and 200 cc. (more accurately 187·5 cc.) of a 1 per cent. solution of platinum chloride. Shake the contents of the bottle up together and put it aside. By the next morning the osmic will have dissolved and the mixture will be ready for use.

Alum carmine is too well-known a staining fluid to every zoologist to require description here; but the very valuable carmine stain recently invented by Dr. Paul Mayer,[3] to which he has given the name of Carmalum ("Carmalaun"), may not be so familiar to the majority of English zoologists. The essence of his discovery consists in using the pure colouring principle, carminic acid, instead of commercial carmine. Carminic acid can be obtained from Dr. Grubler in Leipzig at the rate of about four marks for ten grammes. Having obtained the carminic acid, the method of making up the staining solution is exceedingly simple, and can be carried out as easily in the domestic kitchen as in the well-equipped laboratory, thus: mix together in a suitable vessel one gramme of carminic acid, ten grammes of ammonia alum, and 200 cc. of distilled water. Heat the mixture up to about boiling point, until the ingredients are dissolved, and then, after cooling, carefully pour off or filter the liquid, which is now ready for use. A small crystal of thymol or some other antiseptic should be added, in order to keep it free from organisms. Carmalum is a dark-red liquid with great staining powers, having especially the great advantage that, like picrocarmine, it will give a beautiful stain to objects that have been fixed in pure osmic acid, which alum carmine will not do. It tinges the protoplasm slightly as well as the nucleus,

[2] *Arch. f. Mikroskop. Anat.* Bd. xxxiv. (1889), pp. 58–60.

[3] *Loc. cit.*

hence it is greatly to be recommended, over alum carmine, for objects which it is desired to cut into thin sections, but in the case of objects which it is desired to mount *in toto* it is liable to overstain and render them opaque, and should therefore, in my opinion, be avoided; at any rate, this is so with chick embryos.

I shall now proceed to describe the manner in which this method may be applied to each of the following classes of objects, (1) to cephalopod blastoderms; (2) to chick embryos; (3) to protozoa.

The eggs of Sepia or Loligo are probably well-known objects to the majority of zoologists, and it is not necessary for me to describe them further than by stating a few essential facts about their structure. Although the eggs of the two genera differ widely in appearance they agree in being more or less oval in form and possessing a relatively enormous mass of yolk, at one pole of which is placed the blastoderm, which is comparatively minute at an early stage, though it soon grows over the yolk. Outside the yolk comes a delicate membrane, which, for the sake of description, we may term the chorion, without wishing to prejudge its homologies. In the early stages the chorion is in close contact with the ovum, but separates more and more from it as the embryo becomes formed. Outside the chorion come several gelatinous coats. In Loligo the egg is embedded with a number of others in a common jelly, but in Sepia each egg is separate and has its own concentric coats of jelly.

In order to describe my method I shall take the egg of Loligo, which is rather more difficult to manipulate than Sepia, on account of its smaller size, though for both eggs the method is essentially the same. Moreover, my remarks apply more especially to the earlier stages, from the commencement of segmentation up to the formation of the three layers, during all of which time the blastoderm has the form of a disc or inverted saucer, its curvature being very slight. After it has commenced to grow rapidly round the yolk, it is, of course, impossible to prepare good surface views, for the simple reason that its curved form renders it physically impossible to flatten out the cup-shaped blastoderm without breaking it. Let it be supposed, therefore, that we wish to obtain a series of preparations, either to show the segmentation of the egg and the formation of the germ-layers, or to show nuclear figures.

The first step is to free the egg from its gelatinous envelopes and leave it only surrounded by the chorion. This can be done without much difficulty after a little practice. In Loligo I found it easiest to remove the jelly with a pair of mounted needles in a shallow vessel containing sea-water. The needles employed for this purpose should be as rigid as possible, very springy needles being likely to damage the structures. Now, if one needle be made to pierce the jelly, without of course touching the chorion, and then be held with its point resting on the bottom of the vessel, and slightly slanting, while with the other hand the other needle be made to cross it rapidly in such a way,

that while its point scrapes along the bottom of the vessel its edge scrapes against that of the stationary needle, an exceeding sharp and clean cut can be made through the jelly, which is snipped as cleanly as with a pair of scissors. (See accompanying Fig. 1 and explanation.) With three or four such snips, which, with practice, occupy as many seconds, the chorion is almost completely denuded of its adherent jelly, without the blastoderm suffering the least injury. In Sepia the outer coats of jelly may be removed by simply cutting them with scissors and cautiously squeezing out the egg.

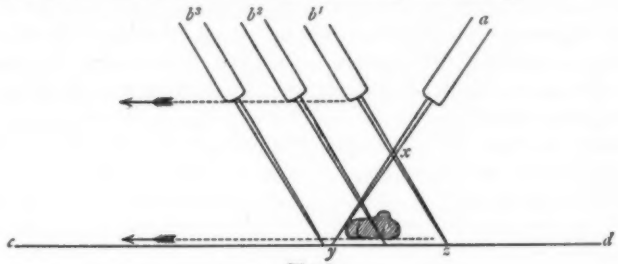


Fig. 1.

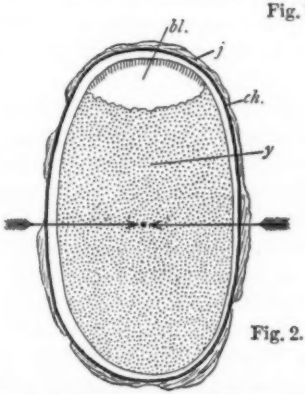


Fig. 2.

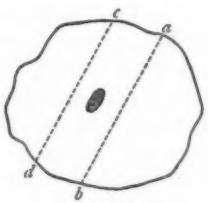


Fig. 3.

FIG. 1.—Diagram to illustrate the method of snipping an object in two with two needles, *a* the stationary needle, b^1, b^2, b^3, three positions of the moving needle, *o*, object, *cd* bottom of the vessel. The arrows and the dotted lines indicate the direction in which *b* moves. The object is at first enclosed in a triangle, *xyz*, the plane of which should coincide with the plane in which it is to be cut. As *b* moves the triangle *xyz* is reduced to a point, and the object, if soft, is irresistibly cut in two in the plane of *xyz*.

FIG. 2.—Cephalopod Egg.—*bl.* Blastoderm, *ch.* Chorion. *y.* Yolk. *j.* Fragments of Jelly.

FIG. 3.—Diagram to explain section-cutting (p. 122).

We now have the egg enveloped only in the chorion, with the minute disc-shaped blastoderm at one end. The blastoderm is transparent and almost invisible. The egg is now removed from the sea-water and dipped into a capsule containing Hermann's fluid. After a few seconds the blastoderm shows up very plainly as an opaque white patch. It should be left for about a minute

longer and then removed to a shallow vessel containing distilled water, for the double purpose of washing out the reagent and of commencing to pick out the blastoderm from the yolk.

The process of freeing the blastoderm from the yolk is a delicate operation and more easily described than done, as it requires much skill and practice in manipulation. The proportion of failures to successes is at first very large. I proceed as follows. The egg naturally falls upon its side, as represented in the accompanying diagram, Fig. 2. The first manœuvre is to spear it right through the middle with a needle, in the spot to which the two arrows are pointing. Then, the impaling needle being held still, a snip is made with another needle in the direction of one of the arrows, after the manner described above, and, immediately after, a second snip in the direction of the other arrow, so as to cut the egg into two halves across its equator. By this method, which is very easy after a little practice, the egg with its enveloping chorion is cut in half cleanly and sharply, without injuring anything, in a way that would be impossible with scissors or knife. One half, of course, contains the blastoderm resting on a hemispherical mass of semi-fluid yolk, and enveloped in a cup-shaped chorion. With a little care the yolk and blastoderm can now be drawn right out of the chorion, which henceforth troubles us no longer.

We now have the blastoderm resting on a rather amorphous mass of yolk. We may be either intending to stain the blastoderm in alum carmine before it has been into alcohol, or we may wish to bring it into alcohol unstained, and then colour it with hæmatoxylin or aniline stains. In the former case, the further removal of yolk is best delayed till after staining. The yolk with the blastoderm still adhering to it is carefully taken up on a lifter (of course, with the blastoderm uppermost) and put into fresh distilled water in order to wash out the Hermann's fluid completely, and thence it is taken into alum carmine, where it should be left one to three hours. At the end of that time it is put again into distilled water, when the yolk very readily separates away clean from the blastoderm, the alum carmine seeming to have a slightly macerating action on the yolk. If, on the contrary, the blastoderm is to be brought into alcohol without staining, the process is exactly the same with the omission of the alum carmine, the blastoderm being left longer in water in order to macerate and separate off the yolk.

The blastoderm, stained or unstained, is now freed from yolk and in distilled water. It is not all plain sailing yet, however. When the blastoderms come into the weaker grades of alcohol, they become excessively sticky, and will adhere to the walls of the vessel, to the needle, or to anything they touch, coming away from it in pieces when detached. Moreover, they have a tendency to curl up. All these unpleasant habits, however, can be cured by a simple device, which I have also found applicable to other objects. It is as

follows. The blastoderm is placed in a watch-glass containing distilled water, in which a coverslip is submerged. The coverslip, of course, only touches the watch-glass with its four corners, and there is a space underneath it, between it and the bottom of the watch-glass. The blastoderm is now carefully floated on to the middle of the coverslip, so that its primitively external or upper surface is downwards and touching the glass. Then with a syringe or pipette the water is carefully drawn off till it falls below the level of the coverslip, so that the blastoderm is left stranded on the coverslip. As soon as this has been effected the coverslip can be lifted up with a forceps with the blastoderm upon it. The blastoderm must not be allowed to dry completely up, but all the superfluous moisture must be drawn off, so that it is pressed closely to the coverslip by capillary attraction. Its cells will then, in most cases, stick very tightly to the coverslip, which is now turned over and transferred to a second watch-glass containing 30 per cent. alcohol, in which it is placed, with the blastoderm *downwards*. It not unfrequently, however, happens that the blastoderm becomes unstuck and flies off with great rapidity when it comes into the 30 per cent. spirit. When this occurs the same performance must be gone through, in 30 per cent. alcohol, as has just been done in distilled water, and the coverslip, with the blastoderm stuck on to it again, is removed into 50 per cent. spirit, of course with the blastoderm downwards. It very seldom comes unstuck a second time. The coverslip, with the attached blastoderm, can now be transferred with the greatest ease from one liquid to another, and stained, if necessary. Finally, it is brought into absolute alcohol, and then into a watch-glass of oil of cloves, without, however, there being sufficient oil of cloves to immerse the coverslip, but only enough to wet the side to which the blastoderm is attached. The coverslip is then placed on a slide, after being supported with wax feet at its corners to prevent the blastoderm being crushed, and mounted in Canada balsam.

In this way most admirable preparations of blastoderms can be obtained, which not only show cell-structure and nuclear division to perfection, but also are all that could be desired from the morphological point of view; the radiating cells, for instance, which, at a late stage of segmentation, spread out from the edge of the blastoderm over the yolk, being most perfectly preserved. I have satisfied myself, by careful examination, that if the method is carefully carried out, no cells are left behind on the yolk. The method of sticking the blastoderm to the coverslip gives the further advantage that, while the blastoderm can be effectually protected from being crushed when mounted on the slide, it is only separated by the thickness of the coverslip from the objective, and can therefore be studied with any power that is desired, however high.

If, on the other hand, it is desired to cut into sections the blastoderm so removed, the process is just the same as above, with the difference that a thin slice of liver is substituted for the coverslip. I

use amyloid human liver kept in weak spirit for this purpose. The blastoderm can be made to stick to it, as a rule, in just the same way as to the coverslip, and then liver and blastoderm together can be cut into sections.

I have used Flemming's fluid instead of Hermann's, but not with such good results. Not only do the objects not stain so well after it, but they become very brittle, and therefore more difficult to extract from the egg. The best stain for general purposes is certainly alum carmine, and borax carmine should be avoided. I have obtained, however, a beautiful preparation for nuclear figures by bringing the blastoderm unstained into alcohol, and then staining it first in gentian violet dissolved in aniline water, and secondly in orange G., washing out both stains at the same time in absolute alcohol.

For chick embryos, the mode of applying this process, though essentially the same, is very different in practice. Here there is no difficulty in extracting, say, for instance, a chick embryo of 36 hours from the egg and freeing it from the yolk, but it is liable to curl up completely in the reagents, and then to get so brittle that it is impossible to straighten it. The method I have employed with good success is as follows. The egg is opened and the blastoderm extracted in the usual way in warm salt solution. The blastoderm is then dipped out with a flat shallow dish, such as the lid of a capsule. Here it is floated on to a small piece of black paper, in which an oval piece has been cut out of the middle, slightly larger than the area pellucida. The blastoderm is placed on the paper in such a way that the embryo and area pellucida are over the hole in the paper. By pressing down the edge of the blastoderm on to the paper with a needle all round it can be made to stick. This part of the process requires rather careful manipulation. The next thing is to carefully remove all the salt solution by means of a syringe, so that the piece of paper with the blastoderm attached is left stranded on the bottom of the vessel. Hermann's fluid is then carefully poured in, in sufficient quantity to cover the paper and the embryo. After it has been in this for a few minutes (until the area opaca is beginning to turn light brown), the paper with the attached embryo may be picked up with a pair of forceps and transferred to distilled water to wash out the reagent. It will be found that the Hermann's fluid has given the blastoderm a certain amount of rigidity, which enables it to resist the strain of being lifted about, combined, however, with a small amount of flexibility. Flemming's fluid, on the other hand, makes it very brittle and therefore more liable to break. If, moreover, it has been properly stuck down on the paper at first (which requires some practice), it will remain sticking and will not curl up. After being washed in two or three changes of distilled water it can be stained, which is best done in alum carmine if it is to be mounted whole, or in carmalum if it is to be sectioned. For mounting it whole there is no need to remove the black paper, the presence

of which makes it easier to shift the blastoderm from one liquid to another, while it does not, of course, prevent the embryo from being studied under the microscope, if it has been carefully stuck over the hole in the paper. If the embryo is to be sectioned it can either be carefully removed from the paper with a needle, after having come into strong alcohol, though it is then difficult to prevent it curling up a little; or the embryo may be embedded, paper and all, in paraffin, and the paper then carefully cut away with a sharp knife by paring down the block of paraffin until only the embryo and area pellucida are left.

Early chick embryos mounted in this way, after Hermann's fluid and alum carmine, in the first place show the general feature (medullary groove or canal, notochord, primitive streak, etc.) most excellently as low power objects, but also show the most perfect cell detail if carefully focussed with a high power. The branching mesenchyme cells are especially well-preserved, and the delicate network formed by their processes is beautifully shown, giving a wonderfully life-like amœboid appearance when focussed down. Nuclear figures are to be seen nearly everywhere. I have not seen any method which gives better results that this very simple one, which only takes about four hours from the time of opening the egg to the time of mounting the embryo in Canada balsam. The alum carmine gives a good stain, but one which is rather too delicate for thin sections, for which carmalum is preferable.

I will finally describe how this method may be applied to Protozoa, say, for example, *Paramecium*.[4] A drop of water containing the animals is placed on a slide and covered by a cover-glass supported at the four corners by wax feet. The drop should be as free as possible from *débris* of all kinds, since it hinders the free passage of liquids through the space under the coverslip. The wax feet should be high enough to keep the Paramecia from being squeezed, but low enough to prevent them being able to move very fast; that is to say, the coverslip should just not touch them. A drop of Hermann's fluid is then placed at the side of the coverslip and cautiously drawn through by blotting-paper (or better, filter paper) placed at the opposite side of the coverslip. In doing this it is necessary to be very careful that the living and freely swimming animals are not swept out from under the coverslip by the current before the reagent has reached them. This may be prevented with a little trouble by drawing the Hermann's fluid half through, and then putting another drop the other side of the cover-glass and drawing it back again. When once, however, the Hermann's fluid gets to them, it not only kills them instantly but also sticks them to the slide, so that rapid currents can be drawn over them without their moving at all. As

[4] This method is really a modification of one which I learnt in Professor Bütschli's laboratory in Heidelberg in 1888. Then I used Flemming's fluid instead of Hermann's.

soon as all the animals have in this way been killed and fixed on to the slide, all difficulty is passed. After the Hermann's fluid has been allowed to act for a few minutes it is washed out with water, drawn through in the same way by filter paper, and when well washed, the stain, alum carmine or carmalum, is run in. This should be left to stand for an hour or so in a damp chamber to prevent evaporation, and then washed with water and brought up through the alcohols into oil of cloves, which is finally succeeded by Canada balsam.

This method, apart from its simplicity and easiness, has the advantage for such forms as Ciliata of preserving cilia, undulating membranes, etc., very well indeed, besides giving good results for the nucleus and internal protoplasmic structures. I do not find it so successful, however, for Amœbæ, for which osmic acid or its vapour, followed by picrocarmine or carmalum, gives better results, though more difficult to apply, since the objects do not become fixed to the slide. I have obtained a most beautiful and instructive series of sections through a *Pelomyxa* which was fixed with osmic acid and stained with carmalum, the sections being further coloured on the slide with various aniline stains. On the other hand, the Hermann's fluid and alum carmine method succeeds very well for *Actinosphærium* and for Gregarines.

I may mention in this connection that I obtained an excellent preparation of a plasmodium of *Badhamia*, that was creeping over a slide, in the following way: after fixing with osmic vapour and staining with picrocarmine,[5] it was floated on to a coverslip in 30 per cent. alcohol, in a watch-glass, and made to stick to it by drawing off the liquid, in the same way as has been described above for cephalopod blastoderms. Not only was the general form of the plasmodial network well preserved, but the minute structure, especially the nuclei, were beautifully shown.

I have now described ways of applying this method of a short exposure to Hermann's fluid, followed by a carmine stain, to three very different classes of objects, which may, perhaps, serve as types for yet others. I believe, for instance, that it would prove a valuable method for studying the segmentation of the egg of the fowl, or of other meroblastic ova. The fixing reagent in question was, however, invented by Hermann to be applied to larger objects for a much longer time, in order to study all detail and nuclear figures, just in the same way as Flemming's fluid is usually employed. Hermann originally employed it for the testis of the mouse and salamander, the organ being removed and hardened *in toto*. I have also obtained very good results, especially as regards nuclear figures, for the testis of the axolotl. Two were removed from an axolotl in October, and placed in Hermann's fluid, one for three days, the other for three months. In the latter the structures were a little darker, but not

[5] Weigert's picrocarmine, prepared by Dr. Grubler of Leipzig.

otherwise altered. They were then washed in running water under the tap for at least 24 hours. It is frequently necessary to wash objects in this way, and when they are small they are liable to be lost. I may recommend, therefore, the following simple and absolutely safe piece of apparatus. A piece of thick glass tubing, about nine inches long, is closed at one end by having a piece of gauze tied over it. It is then supported with the closed end downwards in a vessel about six inches in depth, which stands in the sink.[6] The object to be washed is placed in the tube on the gauze, and water is allowed to trickle from the tap into the upper open end of the tube. The water passes over the object and through the gauze into the outer vessel. When the latter is full it overflows down the sink. In this way even very minute objects can safely be left all night exposed to the current, provided they cannot pass through the gauze. At the same time they are in the direct current.

The testes after being thus washed were hardened in alcohol and cut into sections, and stained on the slide with various anilines,[7] and in this way most successful preparations of nuclear figures were obtained, giving a beautiful differential stain in combinations of different anilines. I have also obtained very good sections of *Lumbricus* in this manner, but here, unless the sections are very thin, they require to be bleached before staining, owing to granules in the cells being blackened by the osmic. Bleaching was done by placing the slide of sections in a bottle of 80 per cent. alcohol, having previously covered the bottom of the vessel with a layer of crystals of chlorate of potash.[8] A few drops of concentrated hydrochloric acid were then cautiously added, and the bottle subjected to slight warmth (by placing it on the paraffin bath). In about an hour's time the chlorine evolved has bleached the sections.

I have above briefly mentioned a method of fixing the cephalopod blastoderms on to thin slices of liver in order to section them. This method is also so useful for orientating minute objects in paraffin for

[6] It is not, of course, in any way necessary that the glass tube and the vessel should be nine inches and six inches in height respectively, but only that the tube should be considerably longer than the vessel is deep, in order that the water which runs through is obliged to pass through the gauze, and cannot overflow from the top of the tube.

[7] For all the anilines used, namely, Safranin, Gentian Violet, Eosin, Fuchsin, Fuchsin S., Dahlia and Orange G., the following recipe (recommended by Hermann, *loc. cit.*) was used for making up the solutions:—

Staining substance (dry)	1 gramme
Absolute alcohol	10 cc.
Aniline water	90 cc.

Anilines made up in this way stain very intensely and sharply, washing out being done in absolute alcohol. Safranin may, however, be washed in acid alcohol. These solutions do not, however, keep very long, especially Gentian Violet, Eosin, and Dahlia, and require to be used fresh.

[8] This method was, I believe, first described by Kühne, as a means of depigmenting retina; it can be used both for objects *in toto*, or, as here described, for sections on the slide.

cutting sections that, at the risk of stating what is already well known, I venture to give an account of how to use it.[9] Let us suppose that the object to be cut is either small and circular, with, however, a very definite axis of symmetry, like a cephalopod blastoderm, or that it is minute and with differentiated axes, like a Paramecium or a sponge larva, and, further, that it is required to cut sections through it having a definite relation to its planes of symmetry, *i.e.*, either transverse or longitudinal. Cut a thin slice by hand from the liver and bring the slice and the object into 90 per cent. alcohol. The slice of liver need not have any particular outline. Place the slice of liver on an ordinary section-lifter, without, however, removing it from the alcohol. Then, holding the lifter with the liver on it in one hand, with the other float the object on to the middle of the piece of liver. Now raise the liver, with the object on it, carefully out of the alcohol, and with the hand that is free let a drop of Mayer's glycerine and albumen solution, such as is used for sticking sections on the slide, fall right on the object, and then at once immerse liver and object again in the alcohol. If this is properly done (it requires a little practice) the albumen will at once coagulate round and over the object and stick it firmly to the liver. If it is not rapidly immersed in the alcohol after dropping the glycerine and albumen on it, the glycerine is liable to cause skrinkage in the object.

We now have the object fixed on the slice of liver, as shown in the accompanying Fig. 3 (p. 115). The next process is to put the piece of liver, still in alcohol, under a lens or low power, and with a sharp knife, carefully cut one side parallel to the object along the dotted line, *a b*; after which the other side can also be cut parallel by the eye along the line *c d*. We now have our object fixed to an oblong piece of liver in such a way that the long axis of the liver corresponds to the long axis of the object, and it is now quite easy to imbed it and cut it, liver and all, transversely or longitudinally at will.

I will finally mention a method which I have found most useful in cutting sections of eggs containing yolk, such as cephalopods, or hard chitinous objects. It was first, I believe, described by Heider.[10] Two solutions are made, one of celloidin, the other of gum mastix, in ether, to which a small quantity of absolute alcohol (about $\frac{1}{10}$ of its volume) has been added. The mastix solution should be thick and syrupy, and the celloidin also as thick as can be got.[11] Equal quantities of these two solutions are mixed together and put away for future use.

[9] I do not know who first invented this method, but I myself learnt it from my friend, Dr. Otto Maas, during my stay in Naples.

[10] "Die Embryonalentwickelung von Hydrophilus piceus, L." Erster Theil, Jena, 1889, p. 12.

[11] Ordinary collodium may be used instead of the celloidin solution.

When a difficult object has to be cut, a small quantity of the mixed mastix-celloidin solution is put into a tube or small bottle, and diluted with ether mixed with a little absolute alcohol until it is quite thin and fluid. We will suppose that, meanwhile, the block of paraffin containing the embedded object is fixed in position on a Jung microtome, or some similar kind of instrument, ready to be cut. Before cutting each section the surface of the paraffin block is painted over with the thin mastix-celloidin solution by means of an ordinary soft paint brush. It almost instantaneously sinks in a little way into the paraffin, and, in the same instant, the ether evaporates, leaving the mastix-celloidin mixture behind. The excess of the mastix-celloidin is then rubbed off with the finger, and the surface of the paraffin block should be polished with the finger by rubbing it several times. If now a section is cut, it will be found to be held together by the mastix-celloidin mixture which has penetrated into the object, and thus prevents the breaking up of the section that so often follows when yolk or chitin is cut. By this simple, if rather tedious, method, I have obtained uninjured series of sections not only through eggs containing yolk, but also through the thorax of a large mygaloid spider, in which the chitin had not been softened in any way. I have sometimes also found it necessary for things stuck on liver, as the liver is liable to become very brittle.

E. A. Minchin.

V.

Recent Additions to our Knowledge of the Eurypterida.

SINCE the publication of Dr. Henry Woodward's "Monograph of the British Fossil Merostomata" in 1878 (3) the number of important papers dealing with this group has been comparatively small. The additions to our knowledge of the true structure of these interesting Palæozoic forms have, however, been of great value, and their zoological affinities may be said to be fairly well established.

The classical works of Huxley and Salter (1), Hall (2), and Woodward demonstrated that the Eurypterids were Arthropods whose body consisted of a carapace followed by twelve free segments and terminating in a telson, the surface being more or less covered with scale-like markings. The under surface of the carapace bore a number of legs—five pairs, according to the above-cited authorities, and it is in connection with these that some of the most important additions to our knowledge have been made. These legs consist typically of a basal joint, the inner margin of which is armed with teeth and serves as a jaw, much as in *Limulus* or *Apus*. At the posterior end of the tooth-bearing margin is attached (6) a small oval epicoxite exactly similar to that found in the same place in *Limulus*, and at the anterior angle is attached the long, usually six-jointed ambulatory appendage.

The last pair of legs is characterised in all members of the group, except *Stylonurus*, by its greater size and usually somewhat flattened form, and ends in an oval plate. This is usually termed the swimming foot, but it seems more probable that it was used for anchoring the animal firmly in the soft mud of the sea bottom, and possibly also for shovelling up the sand and mud when the beast wished to conceal itself.

In *Pterygotus* the most anterior pair of appendages are large pincers, probably prehensile in function, and evidently attached in front of the mouth, as jaw bases are wanting. They seem to have consisted of only three long joints, though owing to the crumpling of the cuticle of the proximal joint there is often an appearance of a greater number. Behind the mouth there are—according to Schmidt (4)—four pairs of ordinary walking legs, followed by the large "swimming

feet." This would make the whole number of appendages six instead of five, as described by Huxley, who only recognised three pairs of walking legs.

In *Slimonia* and *Eurypterus* the full complement of post-oral appendages (five pairs) has long been recognised. In the former the first pair, described by Woodward (3), and by him termed "antennæ," is modified to form tactile organs, but is undoubtedly post-oral in position, as the basal joint bears teeth. Pre-oral appendages have been described in *Eurypterus fischeri* by Schmidt (4) as a pair of fine antenniform structures. In *Slimonia* and in *Eurypterus scorpioides* and *E. conicus* the pre-oral appendages have been described (6) as small stout pincers, much like the cheliceræ in *Limulus*, and corresponding generally to the big pincers in *Pterygotus*, though probably masticatory in function rather than prehensile. The difference between these appendages as described in *E. fischeri* and *E. scorpioides*, etc., is very great, but we must wait for further evidence before making the apparently logical change of dividing *Eurypterus* into two distinct genera, or even families. There would be a certain awkwardness in founding one's classification on a structure which has only been described in three species out of the forty or fifty in the genus.

The legs in the other genera of Eurypterida are less well-known. In *Stylonurus* the last two pairs are enormously elongated. The other legs are only known by fragments, but among the fragments figured in a recent paper by Hall and Clark (5) is a well-marked pair of cheliceræ, which were no doubt pre-oral in position. Limbs intermediate in form between the elongated type of *Stylonurus* and the broad "swimming feet" of *Eurypterus* have been described in *Dolichopterus* (2) and *Drepanopterus* (8).

The hard parts, other than appendages, on the ventral surface of the carapace consisted of the epistoma in front of the mouth and the metastoma behind it. The epistoma was described by Huxley and Salter in *Pterygotus*, but they were misled by the direction of the scale markings on it, and tried—as pointed out by Schmidt—to get it in hind side before. It consists in *Pterygotus*, in which it is best known, of a thin, semicircular plate, which covered the space between the anterior margin of the carapace and the mouth, the pre-oral appendages being attached close to its posterior border. The reversed position of the scale markings, which have their convex side directed forward, would seem to point to its being morphologically the inturned front border of the carapace. It probably corresponds to the hypostoma of Trilobites, which occupies the same position.

The metastoma is a heart-shaped plate attached along the middle line to the ventral wall of the body, between the bases of the last pair of legs and extending outwards and forwards so as to enclose the jaws in a kind of chamber.

The margins of the carapace are often bent over on to the ventral surface to a greater or less extent. This is particularly well-marked

in *Stylonurus*, where more than half of the under sufacee is covered in this way.

The ventral surface of the free segments of the body is much less well-known than that of the cephalothorax. The first two segments are covered by the genital operculum, which consists of a pair of plates meeting in the middle line and having a median lobe attached to them. This median lobe varies in form in the same species according to the sex, and may be considered as a copulatory organ in the male and an ovipositor in the female. In some species, *e.g.*, *Slimonia*, one form of this organ shows distinct signs of having been eversible. Underlying this genital operculum are a number of leaf-like structures, almost certainly branchial in function, which appear to have been attached to the body-wall, not to the operculum, and which, therefore, probably represent the reduced appendages of the second free segment. This segment has lost its ventral hard skeleton, and the appendage has become reduced owing to being covered by the genital operculum.

The appendages of the segments behind these first two have only recently been made out. Schmidt (4) describes them in *Eurypterus fischeri* as consisting of a series of four pairs of plates, each pair united in the middle line, and covering the whole ventral surface of the segment to which it belongs. The ventral surface of the body is, according to his description, entirely devoid of sclerites in these segments, and the plate-like appendages bear branchiæ on their posterior surfaces. He describes, though with less detail, a similar arrangement in *Pterygotus ossiliensis*. In *Slimonia*, on the other hand, the abdominal appendages have been described (6) as consisting also of four pairs of plates, which, however, with the exception of the first pair, do not meet in the middle line, but are successively smaller from before backwards. The ventral surface of the segments has, further, well-developed sclerites extending across the whole width of the body. In both cases the chief point is established that the Eurypteridæ had plate-like abdominal appendages bearing branchiæ on their posterior surfaces, and, in a general way, comparable to those of *Limulus*.

Fragments of some very interesting forms have been described from the Lower Carboniferous by Peach (7) under the name of *Glyptoscorpius*. These fragments appear to have belonged to a large animal (over 1 foot in length), the surface of whose body was covered with highly-developed scale markings. The limbs ended in a double claw similar to that of the Scorpions, and the animal was further provided with a pair of appendages closely resembling in structure the pectines of Scorpions. This form was probably aquatic in its habits, and represents not the direct ancestors of Scorpions, for they had appeared long before, but a collateral branch. True Eurypterids existed simultaneously with this form, though possibly many so-called Eurypterid fragments from the Carboniferous belong really to *Glyptoscorpius*.

As regards the zoological position of the Eurypterids, the establishment of the number of cephalothoracic appendages as six, the first pair being pre-oral and—at all events, in most forms—cheliceræ, seems to considerably strengthen the argument for their relationship to the Arachnida. The presence of abdominal appendages also makes them agree much more closely than before with *Limulus*, and, if the lung-books are to be derived from such appendages, with *Scorpio*, &c. It has been pointed out, however, (6) that the great development of the genital operculum and consequent partial suppression of the second free segment is a point of some morphological importance, and contrasts strongly with the development of the same parts in *Limulus*, and even more strikingly in *Scorpio*. On the other hand, it agrees very closely with the arrangement in the Pedipalpi, in which a similar suppression of the second segment has taken place, and it seems probable that these latter are more nearly allied to the Eurypterids than are the Scorpions. This view would tend to separate *Glyptoscorpius* somewhat from the Eurypterids, but as the only evidence of relationship is the presence of scale-markings which are common to many other forms (Trilobites, Phalangidæ, etc.), there can be no serious objection to this. The relationship of these forms to the Crustacea is not so evident, as they show no special points of affinity with any one group. The absence of that special modification of three pairs of appendages to serve as mouth organs, which is characteristic of all crustacea except the Ostracoda, indicates that their point of union must have been very low down the Crustacean stem, and the very definite number of segments and arrangement of appendages in the Eurypteridæ indicates on the other hand that they are removed a considerable distance from any such primitive type. Insofar as they are somewhat more primitive forms than the recent terrestrial Arachnids, they may undoubtedly be said to be nearer to the point of union of the Crustacean and Arachnid lines of descent, but, unless great, and, it seems to me, undue importance is to be attached to their aquatic mode of life, they can hardly be termed intermediate forms.

REFERENCES.

1. **Huxley and Salter.**—Anatomy and Affinities of Pterygotus. *Mem. Geol. Surv. Monograph* i., 1859.
2. **Hall, J.**—Natural History of New York. Palæontology, vol. iii.
3. **Woodward, H.**—British Fossil Merostomata. *Mon. Palæontographical Soc.*, 1866-1878.
4. **Schmidt, F.**—Die Crustaceenfauna d. Eurypterusschichten v. Rootzikülll. *Mém. Acad. Imp. Sci. St. Pétersbourg*, vol. xxxi., 1883.
5. **Hall, James.**—2nd Geol. Surv. Pennsylvania. Vol. P.P.P., 1884.
6. **Laurie, M.**—Anatomy and Relations of Eurypterida. *Trans. Roy. Soc. Edinb.*, vol. xxxviii., 1893.
7. **Peach, B. N.**—Crustacea and Arachnida of the Carboniferous Rocks. *Trans. Roy. Soc. Edinb.*, vol. xxx., 1881.
8. **Laurie, M.**—Some Eurypterid Remains from the Pentland Hills. *Trans. Roy. Soc. Edinb.*, vol. xxxvii., 1892.

MALCOLM LAURIE.

VI.

Supposed Fossil Lampreys.

SOME months ago, in dealing with our knowledge of the "Forerunners of the Backboned Animals,"[1] reference was made to a singular little organism, *Palæospondylus gunni*, which seemed to indicate the existence in the early Devonian period of a highly-organised member of the group to which the modern lampreys and hag-fishes belong. This fossil, it will be remembered, was discovered by Dr.

Restoration of *Palæospondylus gunni*, somewhat enlarged, by Dr. R. H. Traquair. *c.* cirri; *t.p.* anterior part of cranium; *p.a.* posterior part of cranium; *x.* paired plate-like structure behind the head.

Marcus Gunn in the Lower Old Red Sandstone of Caithness, and our notice was based partly upon the brief original description by Dr. R. H. Traquair, partly upon some specimens obtained by Mr. Donald Calder, of Thurso. We are now glad to announce that, within the last month, Dr. Traquair[2] has published a fuller and more accurate description of the organism, based upon new specimens; and the

[1] NATURAL SCIENCE, vol. i., pp. 596–602 (1892).

[2] R. H. Traquair, "A Further Description of *Palæospondylus gunni*, Traquair," *Proc. Roy. Phys. Soc. Edinb.*, vol. xii., 1892–93, pp. 87–94, pl. i.

announcement is made with all the more satisfaction, since we are able to confirm his emendations and conclusions from a personal examination of a fine series of specimens kindly lent by Mr. Wm. Tait Kinnear, of Forss. Thus far the fossil has only been met with in a single stratum at one quarry near Thurso, and the circumstance is a striking illustration of the accidental character of palæontological discovery, inspiring hope for the future in problems which yet seem beyond solution.

Dr. Traquair appends some good figures of his new specimens of *Palæospondylus*, but we only copy his restored outline in the accompanying illustration. It is now proved that the appearance of a great ring-like lip-cartilage, indicated in our former figure in NATURAL SCIENCE, is due merely to the crushed rim of the anterior part of the skull (*t.p.*), which Dr. Traquair thinks may be equivalent to the palatine region of the lamprey's skull. There is still, however, no evidence of jaws; and it is not quite certain whether the nose was single or paired. The supposed dorsal shield behind the head curiously proves to consist of a pair of oblong plates, apparently not external, but certainly not yet capable of interpretation. Between these the ring-vertebræ are spaced, but behind they form a continuous chain. There are short and stout neural spines in the abdominal region, but no ribs; and the slender neural and hæmal spines in the short caudal region prove to be as already described. No traces of paired limbs can be detected in any specimen.

That *Palæospondylus* is one of the forerunners of the modern Marsipobranch fishes, as Dr. Traquair originally suspected, is thus rendered still more probable by the latest researches. We can only hope that, ere long, similar skeletons may be discovered in a finer and more compact matrix than that of the Caithness flagstones, where the bituminous character of the fossils usually obscures the smaller details.

A. SMITH WOODWARD.

VII.

The Origin of Monocotyledonous Plants.

IN the recently-issued number of the Linnean Society's Journal (vol. xxix., p. 485) is a paper by the Rev. George Henslow, entitled "A Theoretical Origin of Endogens from Exogens through Self-adaptation to an Aquatic Habit." Endogens are, of course, monocotyledons and exogens dicotyledons, and the author argues that the former originated from the latter as the result of adaptation to an aquatic habit. It may be of interest to see on what grounds he bases this theory of the origin of one great group of angiospermous plants from the other.

Of geological evidence there is none, and in the paragraph headed "Survivals" the calculation is not easy to follow. We read, "the belief that endogens are of very early origin is supported by the fact that so many orders of this class include very few genera. Thus, according to the 'Genera Plantarum' of Bentham and Hooker, there are 13 orders out of 166 which have only four or a less number of genera, while two orders have six. Taken together, therefore, these amount to nearly 8 per cent. of the whole class. It need hardly be added that monotypic animals and plants, as well as those orders and genera with but few members, are always regarded as survivals on the principles of evolution and represent a lost ancestry." According to the "Genera Plantarum" there are only 34 monocotyledonous orders, 15 of which, or 44 per cent., contain six genera or less. 165 orders of dicotyledons and three of gymnosperms are recognised. That there is some connection between an aquatic habit and endogenous structures is evident from the proportion of aquatic orders; for, while only 7 per cent. of exogenous British orders are aquatic, the proportion of endogenous orders is 53 per cent.; and of the 224 exogenous orders given in Le Maout and Decaisne's "Analytical Botany," nine may be regarded as aquatic, or 4 per cent.; and of 55 endogenous orders, 18, or nearly 33 per cent.

The numerous points of similarity in morphology, anatomy, and histology between the two groups are adduced as evidence of community of descent. Indications of an adaptive character are also to be seen everywhere, and the author's object "is to show that many of the characters common, more especially to the vegetative organs of endogens, and regarded as points of affinity, are just those

which are characteristic of the adaptations of exogens to an aquatic, and, in some cases, to other habits of life."

As regards the points of difference between the two groups, a most important one lies in the structure of the embryo, in the presence of one or two cotyledons. To quote again, "assuming a monocotyledon to have descended from a plant with two cotyledons through an aquatic habit, do we find any instances in support of this view among existing dicotyledons, which are now aquatic, or have presumably descended from water-plants?" *Trapa natans* is instanced. The view generally taken of the embryo of this plant is that there is one perfect cotyledon, and one rudimentary. Drs. Gibelli and Ferrero, who have lately studied the embryology, consider, on the other hand, that the mature embryo is an amorphous mass or true thallome on which is developed a single bud, the plumule; it is, in fact, a degradation resembling that of parasitic and semiparasitic plants, such as Orchids, *Orobanche*, *Balanophora*, etc., and of some aquatic genera, *e.g.*, *Zostera*, *Hydrocharis* and *Utricularia*. Hence, from the example of *Trapa natans* it is quite as legitimate, perhaps more so, to conclude that endogens originated from exogens through a parasitic as through an aquatic habit. *Ranunculus Ficaria* is given as another case. It is admitted, however, that it is not a true aquatic plant, but has, the author thinks, without doubt descended from an aquatic ancestor, one of the reasons being that it has only one cotyledon! This may be, but it is rather begging the question to use it as an example in support of the aquatic theory.

The most instructive instance, however, it is said, would seem to be that of *Carum Bulbocastanum*, which has a monocotyledonous embryo, and an embryology almost identical with that of *Sparganium ramosum*, while its final form is that of the wheat embryo. *Carum Bulbocastanum*, however, inhabits chalky fields, and, like *C. Carui*, in which also one cotyledon is frequently rudimentary, is decidedly not aquatic. Again, the difficulty is got over by supposing that these two species, as well as other umbelliferous genera with linear cotyledons and finely dissected foliage, were ancestrally aquatic; but linear cotyledons are no proof of an aquatic habit, as will be seen by turning over the pages of Sir John Lubbock's "Seedlings"; in the case of umbellifers the shape may facilitate their escape from the often tough-walled fruit. *Hydrocotyle vulgaris*, the aquatic umbellifer *par excellence*, has ovate cotyledons. Anyhow, we can hardly accept these as evidence.

Utricularia, again, has the undifferentiated embryo so characteristic of Orchids and other parasites, and cannot be classed as monocotyledonous. *Erigenia bulbosa*, an anomalous umbellifer, growing in damp and flooded places, has also a very reduced embryo.

In *Cyclamen* the cotyledons first appear as two small eminences, one of which grows no further, while the other forms a large green leaf, resembling in all respects a foliage leaf. Gressner, however,

maintains that both cotyledons become leafy, but in any case the embryo and early stages of growth of *Cyclamen*, which, whatever its ancestry, is certainly not now aquatic, bear no great resemblance to that of an ordinary monocotyledon.

Mr. Henslow admits that more than one cause may produce the same or analogous effect, and that while he attributes the total or partial arrest of one cotyledon to an aquatic habit, a similar arrest may arise from atrophy in consequence of the way in which the embryo is folded in the bud, as Sir John Lubbock has shown to be the case in *Abronia arenaria*. The fact, however, remains that not a single undisputed instance is given of the arrest of one cotyledon producing a monocotyledonous embryo in any aquatic exogen. The wholesale degeneration to a quite undifferentiated embryo, as obtains, for instance, in *Utricularia*, does not help the theory.

In the section headed "The Embryo" the author refers to an observation of Van Tieghem's "that the angular divergence between the cotyledon and the next new organ is 180° (generally in endogens), or, if lateral, 90° (as in exogens). When this latter case occurs in endogens, it implies that one cotyledon is due to an arrested condition of the other of two opposite cotyledons; so that the first leaf belongs to a second pair decussating in position with the cotyledons. If the first leaf be at 180°, then it would appear to have usurped the position of the cotyledon that is lost; but it is not strictly on the same level as the cotyledon, inasmuch as the first leaf is completely included within it, as may be seen in *Asparagus*, figured by Irmisch." Thus whether the first leaf alternates with or is opposite to the cotyledon the latter may be supposed to represent the survivor of a pair. No instance is given of the alternate position, but *Tamus communis* is quoted as a parallel instance to *Asparagus*, in which Dutrochet has shown that the first leaf is exactly opposite the cotyledon, is very rudimentary, and dies early, and he has no hesitation in calling it a second cotyledon. The appendage to the embryo opposite the single cotyledon of certain grasses, which several botanists regard as a rudimentary cotyledon, is also instanced.

We can, however, hardly accept these as proof of the origin of the endogenous embryo from an exogenous by assumption of an aquatic habit. In reflecting on the monocotyledonous embryo, we are struck with the variety of form manifested, rather than by evidence of arrest or degeneration. Of course in Orchideæ we see the degeneration, or want of differentiation, characteristic generally of a more or less parasitic habit, and the same holds in Burmanniaceæ; but in the Palms, Grasses, Scitamineæ, and Bromeliaceæ the cotyledon is a complex structure, comprising two distinct, and often clearly-separated portions; one the sucker, resident in the seed, dissolving and absorbing the store of endosperm, the other the sheath, pushing above ground, becoming green, and protecting the developing plumule. Many Irideæ have embryos built on the same plan, but

occasionally, as in *Sisyrinchium*, and sometimes in *Iris*, the apex of the cotyledon, having functioned as a sucker, follows the lower part out of the seed, the whole appearing above ground as a subulate green leaf in the characteristic liliaceous fashion. In the Hydrocharideæ and Naiadeæ, the hypocotyl and cotyledon are sometimes coherent into a more or less oval mass terminated by a small radicle, but in others, as *Stratiotes* and *Halophila*, the single cotyledon is distinct from the hypocotyl, and in the former genus large and fleshy. It is also large and distinct in *Alisma*. The absence of distinction between hypocotyl and cotyledon crops up now and again in dicotyledons, and is not necessarily connected with an aquatic habit. It has been already mentioned in *Utricularia*, but is also well shown in the Brazil nut (*Bertholletia*) and another closely-related myrtaceous plant, *Lecythis Zabucajo*.[1]

The sheathing petiole so characteristic of the leaves of monocotyledons, is next brought forward in support of the theory, as it also obtains in many aquatic exogens, *e.g.*, Ranunculaceæ, Umbelliferæ, etc. It is especially characteristic of the Umbelliferæ, but unless we assume this an aquatic order, it seems equally well adapted to land plants, especially herbaceous ones with large leaves, where it will materially strengthen their attachment to the main axis. In the enormous leaves of palms this factor must be a very important one; in fact, it seems to supply a more rational explanation than the persistence of an adaptation to an aquatic habit. If such a habit is the cause of the sheathing form of leaf, why is the form so extraordinarily well-developed in the grasses, which is not an aquatic order. The argument is, however, pushed still further, and it is suggested that the coleorhiza, the sheathing portion which encloses the root in grasses, is a development of the sheath, representing the decurrent sheaths of two united cotyledons, or, perhaps, of one only completely investing the axis.

The "pseudo-coleorhiza" of *Tropæolum* is introduced as throwing light on the origin of the root-sheath in endogens; and the author proceeds to adduce several points in favour of an ancestral aquatic habit for the genus, as nowadays it is, unfortunately, a land plant.

In the first place, however, as Mr. Henslow himself mentions, the structure in *Tropæolum* is formed from the bases of the cotyledons, which are sagittate, being produced downwards on either side as four lobes surrounding the embryo, so that if we suppose them to be completely welded together, "they would form a perfect coleorhiza over the end of the radicle"; but this is no argument in favour of the origin of the coleorhiza from a sheathing petiole.

Thus we cannot agree with the statement with which the first part of the paper concludes, viz., "that there is at least enough presumptive evidence to frame a theory that the monocotyledonous embryo has been derived from a dicotyledonous one by a suppression of one cotyledon"; the cause of the suppression being "the degene-

[1] *Cf.* Lubbock's "Seedlings," vol i., pp. 539–41.

rating effect of the aquatic medium in which the ancestral endogens originally and primarily grew."

A large part of the remainder of the paper is devoted to evidences furnished by the order Nymphæaceæ, which is remarkable for having many points of agreement in structure with endogens, and, as it is aquatic, may be looked to in support of the theory.

As regards the embryo, some abnormal cases of the yellow water-lily (*Nuphar luteum*) described by Hegelmaier are cited, where the two cotyledons were more or less united, and the two halves very unequally developed. These are quoted as "an important and independent witness to the gradual arrest of one cotyledon." It seems rather a teratological phenomenon likely to occur anywhere.

In discussing the arrest of the primary root, Mr. Henslow is, we think, clearer, and adduces what is, at first sight, a more promising piece of evidence. A very characteristic feature of monocotyledons is the disappearance of the primary root, that, namely, produced by elongation of the radicle of the embryo, and the subsequent development of adventitious roots. Now this also obtains in Nymphæaceæ, aquatic umbellifers, and other water-loving exogens. Hence the argument that its presence in endogens which to-day are not aquatic, *e.g.*, grasses, is due to inheritance from aquatic ancestors. It must, however, be remembered that fibrous roots occur in exogens which are not aquatic, and as regards the grasses, one of the largest orders of Angiosperms, when we remember their habit, and how they frequently grow in loose soil or dry exposed situations, the spreading fibrous root seems to meet the case so perfectly that the hypothesis of an aquatic ancestry appears unnecessary. Following a suggestion of Mirbel's, the author explains the arrest of the primary root in endogens as follows. When the cotyledons are raised above ground and act as leaves, they can maintain the existence of the tap-root and enable it to grow until the foliage of the plumule is sufficiently developed to carry on the work. If the cotyledons remain below ground, "the plumule *at once* develops its leaves perfectly, as in the oak, and its foliage can then nourish the tap-root instead of the cotyledons doing so." In submerged aquatic plants the first leaves are more or less rudimentary, and, "being under water, their assimilating powers are greatly impeded," so that the primary root perishes for want of nourishment.

Now, as a matter of fact, as Sir John Lubbock points out in his "Seedlings" (p. 356), when the cotyledons remain beneath the ground the plumule does not, as a rule, "*at once* develop its leaves perfectly," but the primary ones are reduced to scales, often passing gradually into the form of the adult leaf. This happens in the oak, and the tap-root is nourished, not by the plumule, but by the fleshy cotyledon, which also supplies nutriment for the growth of the stem. In this way the first green foliage leaves are borne well up in the air and raised above the humus, dead leaves, etc., which might have buried

the seed. Mr. Henslow observes that the seeds of aquatic endogens are generally exalbuminous, but as the hypocotyl or hypocotyl and cotyledon are very much enlarged, there seems no more reason for starvation of the primary root than in the case, for instance, of the oak.

In the same section it is remarked that the arrest, presumably as the result of an aquatic habit, is not confined to the primary root in the Nymphæaceæ (where, by the way, there is a good stock of albumen in the seed), but is continued into the first-formed leaves which pass through various stages of development. Now, if Mr. Henslow will refer again to the work on "Seedlings," he will find that this gradation is quite the rule where the adult form of the leaf is not a fairly simple one. See, for instance, the figure of *Clematis* on p. 82, where the mature, much-divided form is only gradually assumed.

Attention is also drawn to the agreement between these and occasionally other aquatic exogenous orders and endogens in several points of anatomy. Such are the scattered closed bundles and the large wood vessels which are probably "due to the particular degenerating effect of a watery habitat." As the author himself observes, such appearances are by no means confined to water plants among dicotyledons. Any habit which allowed a relaxation in the effort for self-support, such as that of climbing, might, and in fact does, have a very similar effect. It is pointed out that the arrangement in *Peperomia* is practically identical with that of *Commelina*. Analogous degradations occur in parasites, *Cynomorium coccineum* and *Helosis guyanensis* having the bundles "scattered through the ground-tissue, exactly like any endogenous stem."

As regards the comparison of the foliage of *Victoria regia* and *Sagittaria*, considering the close relation in form between the adult leaves, *orbicular-peltate* and *sagittate* respectively, it is not remarkable that the stages by which the normal form is reached should be similar.

From its resemblance to cotyledons "the prevailing ribbon-like form of submerged leaves of endogens," seen also in *Hippuris* and *Callitriche*, is regarded as of a more "embryonic" character than the dissected type of submerged leaves of exogens, and the conclusion is drawn "that those terrestrial endogens which still retain a linear form (*e.g.*, grasses), or ensiform (Iris), or other similar type of leaf or rather phyllode, may be regarded as representing the ancestral submerged ribbon-like form"; while those with distinct lanceolate or cordate blades, like *Convallaria* or *Maianthemum*, "represent the floating types of existing aquatic endogens." The sagittate form seen in many aroids has primarily arisen like the same forms in Nymphæaceæ and *Sagittaria* from an aquatic habit. This reasoning seems based on somewhat superficial characters. We find classed together as representing one type leaves so totally different as the linear grass

leaf and the ensiform one of the Iris. The former has a well-marked dorsi-ventral structure and a clear differentiation into distinct sheath and blade, separated by the characteristic ligule. Moreover, anatomically, the blade is that of a normal aërial leaf. The Iris, on the other hand, has equally well-marked isobilateral structure and properties. It is dangerous to draw conclusions from similarity in shape. Is the tendency towards a cordate form in the geranium leaf the result of a former floating habit, and the still more divided outline in some species evidence of a former submerged state? The hypothesis of the origin of the aloëidal type of leaf from an ancestral form like *Stratiotes aloides* seems as gratuitous.

In the section headed "Venation," the author again attempts to show that the terrestrial leaves of endogens are primarily aquatic, but have taken on aërial features, such as reticulations, stomata, etc., the idea being that a parallel or curvinerved venation is an aquatic adaptation.

The facility of tearing seen in the submerged leaves of *Nymphæa*, in those of bananas, palms, and blades of wheat, is referred to an enfeebled structure primarily due to a watery life. One can, however, see a nearer cause in the case of leaves like the banana and palm, which are not at once shed from the stem, but gradually droop. This process will be aided by the tearing, and they will occupy less space, and cause less drag on the stem, than if they remained entire. We think, too, that a better explanation of the holes in *Monstera* leaves might be found than descent from an aquatic fenestrated leaf like that of *Ouviranda*.

Finally, as regards the flower of endogens, the author suggests that the local stimulations set up by insects may equalise, if not surpass, the degrading influences of an aquatic medium. Presumably, this has happened in three important aquatic orders—Hydrocharideæ, Pontederiaceæ, and Alismaceæ—where the flowers are certainly conspicuous. As, however, a large number of genera of Naiadaceæ, Typhaceæ, Juncaceæ, Cyperaceæ, and others are greatly degraded, it is claimed that "the evidence from coincidences is accumulative, while comparative anatomy justifies the conclusion that there has been a distinct 'cause and effect' in the reduction of the floral structures."

The evidence given, however, does not seem particularly conclusive, comprising a derivation of the spike or spadix of Aroids, Typhaceæ, *Potamogeton*, and others from the branched inflorescence of Alismaceæ and Juncagineæ by suppression of the flower stalks and perianth whorls, and the reference of the quaternary arrangement of the floral organs to a reversion to a very primitive condition of an opposite and decussate arrangement. The suggestion is put forward in a foot-note that the use of the lodicules of grasses is to act as reservoirs of water; it is, however, not easy to see why water reservoirs should be wanted in a grass-flower.

Having briefly reviewed the evidence advanced in favour of the theory, we can only say that whatever has been the origin of monocotyledons, their origin from dicotyledons "by self-adaptation to an aquatic habit" does not seem to have been established in the paper before us. Mr. Henslow has instanced many points illustrating a community of descent of the two groups, and also shown that, in each, plants adapted to a watery habit have certain morphological and anatomical resemblances, as community of descent would in fact lead us to expect, but in our opinion he has not established the origin of one from the other. The study of the origin of great groups is a most fascinating one, but it is also extremely difficult, and one especially in which superficial resemblances must not be pushed too far.

A. B. Rendle.

VIII.

The Recapitulation Theory in Biology.

I HAVE read with interest the articles on the above theory by Dr. Hurst and Mr. Bather in NATURAL SCIENCE for March, April, and May. Mr. Bather states that my work has been inspired by the Recapitulation Theory; and Dr. Hurst is pleased to retort that this is a fantastic theory accepted as a creed by myself and others. Now I am not altogether sure that Mr. Bather is absolutely correct in speaking of my work as inspired by the Recapitulation Theory; what I have upheld is a "Law of Earlier Inheritance." That this law, of necessity, leads to a theory of recapitulation is no doubt true; but it is the law of Earlier Inheritance which has guided my work. Upon this law I have set forth my views, and have shown by comparisons of the ontogeny with the (say, assumed) phylogeny in Ammonites that recapitulation is and can only be imperfect.[1] As these views are fully detailed in a paper on "Some Laws of Heredity,"[2] I need not go over that ground again. Dr. Hurst will find that I have fully taken into account the similarity of embryos of dissimilar species—which seems to be a stumbling block to his acceptance of Recapitulation.

I will assume that Dr. Hurst has not read this paper, or any notice of it; in which case it is curious that, approaching the subject from a totally different point of view, he has defined variation in nearly similar, though wider, terms to what I used some months before.[3]

So far I will suppose that Dr. Hurst and myself are practically in agreement; but it is useless to discuss a question of this kind unless the one knows exactly what the other requires. My object, therefore, is to point out where it seems necessary for Dr. Hurst to amend his statement.

In page 198 Dr. Hurst denies any *causal* relation between ontogeny and phylogeny; in page 197 he says, "the more the adult structure comes to be unlike the adult structure of the ancestors, the more do the late stages of development undergo a modification of the same kind." By "late stages of development" Dr. Hurst means, I presume, premature development—a point I will notice later. Now, as it stands, the sentence conveys to the mind the idea that the premature stages of an individual become altered in consequence of alteration to the mature stages, which are not formed till later. This

[1] Inf. Ool. Ammonites (*Pal. Soc.*, 1892), part vi., p. 288, footnote 2.

[2] Proceedings Cotteswold N. Club, vol. x., part iii., p. 258, Oct., 1892. Translated into German, forming vol. xviii., series i., of *Darwinistische Schriften*, March, 1893.

[3] *Op. cit.*, p. 261.

is clearly an impossibility—any changes in the adult man of 30 cannot affect his structure when he was a boy or child; nor do I imagine that Dr. Hurst means this, though his sentence seems to imply it. If, however, he wishes to say that the more the adult man comes to be unlike his ancestors the more do the premature stages of his descendants undergo a modification of the same "kind," he has obviously admitted the causal relation between ontogeny and phylogeny which he wishes to deny.

There is another sentence in the same page which puzzles me entirely—"in order that any structure of the adult which varies, and hence ceases to exist as an adult structure at all." The word "structure" seems to be open to objection. I presume Dr. Hurst means "character," but then I do not understand the "hence," unless Dr. Hurst wishes to say "and hence ceases to exist *solely* as an adult structure." An adult "structure" may vary in the direction of becoming greater or less, and yet may remain an adult "structure," but it will not remain solely an adult "structure." By the law of earlier inheritance illustrated in Mr. Bather's table (p. 279), it gradually becomes an adolescent "structure." Thus, if the adult "structure" be x, and it varies in subsequent generations gradually to become $2x$, the adolescent "structure" will by then be x; and as in subsequent generations adult $2x$ becomes $3x$, the adolescent x becomes $2x$. Hereby we obtain a record; yet Dr. Hurst says that in order to produce a record "as the adult structure varies in one direction, the late stages of development must vary in another direction." The question is, then, what does Dr. Hurst mean by "late stages of development"? and, also, what meaning ought to be attached to the phrase? The dictionary explains development as "the series of changes in the growth from first to last of an organised being." Obviously, growth includes not only increase as a whole, which in some organisms is continuous throughout life, but it also includes increase in any part. Thus, the growth of hair on man's chest in middle life is part of his development, and the expansion of the stomach in senility is also part of his development. I contend that the late stages of development are the stages of senility; and that to give the term any other meaning is a mistake, which, I am aware, is not confined to Dr. Hurst.

Further, I contend that loss of teeth and loss of hair in man are part of his development—though they are strictly retrogressive phases of development. Then under these circumstances I must ask Dr. Hurst what he regards as acceleration of development, because he probably uses the term in a different sense to that in which I have been accustomed to see it employed.

Lastly, in regard to development, I would remark that, in any discussion, it is most important to clearly distinguish the stages of development in ontogeny and the stages of development in phylogeny; for what Dr. Hurst has written fails to convince me that there is not a close connection between the two.

S. S. Buckman.

IX.

Professor Blake "On the Bases of the Classification of Ammonites."[1]

THE above is the title of the Presidential Address to the Geologists' Association. No wonder that the members of that association were pleased. Professor Blake is just the man for the task, he is "one of the best geological critics in England"—at least, so we have been told, and we are frequently reminded of the fact; he has studied the Cephalopoda, and he has written upon them, and treated them from the mathematical point of view; he is a member of the Council of the Geological Society, and he gave his address as president of the Geologists' Association. No wonder that the members of that association, who were so thankful "for his concise account of one of the most difficult groups of animals—the Cephalopoda"—published last year, should be glad of enlightenment concerning the classification of Ammonites.

Hitherto the members of the association as a whole have been somewhat at sea about Ammonites. It was a dangerous experiment for one of them to air any of the new (?) generic names in the hearing of his fellows. The powers that be, so he was promptly told, still clung to the good old genus *Ammonites*, with its six or seven thousand species; and new generic names were tabooed. No division of this grand old genus could be allowed, even though Professor Blake had, nearly twenty years ago, shown what could be done in the generic division of Ammonites. At last Professor Blake thought the time had come to rescue the members of the Geologists' Association from outer darkness, and accordingly he has once more bravely tackled the question of these new generic names.

According to Professor Blake the chief bases of Ammonite-classification are four—the form, the size (!), the ornaments, the sutures. He mentions other characters, for instance, the length of the body-chamber, only to dismiss it with the extraordinary remark that "if the interior part of the whorl be occupied by the previous whorl, the loss of space is apt to be made up for by the length of the last chamber; but no general rule can be laid down." We should think not, except

[1] ON THE BASES OF THE CLASSIFICATION OF AMMONITES. Presidential Address. Proc. Geologists' Association, vol. xiii., part 2, pp. 24–40, 1893.

it was to state exactly the opposite. How closely Professor Blake has studied recent literature, to find that the length of the body-chamber is considered of the least value among present-day authorities! We have not been able to do so; but we do not wonder at it, because, in our opinion, to consider the *length* of the body-chamber only is absurd. What is required is the *capacity* of the body-chamber. In an evolute, divergent-sided Ammonite the length of the body-chamber would be short, but its capacity might be exactly the same as in an evolute, compressed Ammonite with a body-chamber three times the length. The capacity of the body-chamber, in proportion to the whole shell, may become a basis for classification—its mere length never can be.

The form of the Ammonite is stated to depend on the curvature (p. 25). Alluding to the fact that he published a mathematical paper on the subject, Professor Blake proceeds to explain how to measure the curvature. He gives us three methods. He first "assumes that the rate of curvature of the inner edge is the same as that of the outer." But of what use is this method among Ammonites? The rate of curvature of the inner edge must always be greater than that of the outer edge which subtends it, otherwise Ammonites would very soon fulfil the Yankee's definition of a point—"the small end of nothing whittled down." Nevertheless, our mathematician proceeds to use this wonderful method, and finds thereby that there is considerably less curvature in an involute Ammonite than in an open-whorled *Crioceras*! Now if we take his second method and apply it to the very figures he has given us—the curvatures of the involute Ammonite and of the open-whorled *Crioceras*, work out the same within 0·01.

In the next paragraph we are introduced to the wonderful "*Ammonites transmogrificabilis*, Blake;" and the Professor sets himself to contradict what he had stated in the paragraph above. As a result of his measurements he found that an involute Ammonite had a smaller curve than an open-whorled *Crioceras*; here he tells us that "*without altering the curvature*"—the italics are ours—he can make at will an involute Ammonite or an open-whorled *Crioceras* by means of some wonderful diagrams (pl. i., figs. 3, 4, 5). When, however, we come to apply to these figures his first method of estimating the curves—the method he himself thought fit to employ for figs. 1, 2, pl. i.—we find he has altered the curvature very greatly, for the ratios are fig. 3, 1·53; fig. 4, 1·44; fig. 5, 1·25; and "the greater the ratio the less the curvature" (p. 26).

Now, we confess to little mathematical faculty ourselves. To us a sum is like a joke to the proverbial Scotchman—only to be done *weeth deefeculty*; but even our inferior faculty would have suggested that to estimate the curve of an Ammonite-shell it was necessary to consider not only the peripheral, but also the antiperipheral, or inner-marginal curve. There is no difficulty in seeing that the inner-

marginal curve in fig. 4 is greater than in fig. 5, and that in fig. 3 greater than in fig. 4. We should have supposed that to estimate the curves of these shells it was necessary to take the mean of the peripheral and anti-peripheral curves—by which method, of course, fig. 3 is curved the most.

Professor Blake takes all this trouble about the curves to prove, first, that "an involute Ammonite *(Phylloceras)* has *more curvature* than an open-whorled *Crioceras*"; secondly, that "the difference between the form of *Phylloceras*, *Arietites* and *Crioceras* has *nothing whatever* to do with their curvature,"—two statements which do Professor Blake great credit, as they do not contradict each other in the least!

In dealing with the involution, Professor Blake makes the remarkable statement that Ammonites are necessarily more evolute in youth than in later life. *Am. salisburgensis*, Hauer; *Amm. gonionotum* and *fallax*, Benecke; *Amm. polymorphus* and *dimorphus*, d'Orbigny; *Am. polymerus*, Waagen; *Am. brocchi*, Sowerby; and the majority of the *Stephanocerata* support this view, we suppose. Really Professor Blake's perception must be keen; he sees what no one else could do in the matter of these Ammonites. Then he proceeds to say that Hyatt and Buckman seek an evolute ancestor for every form, and finds fault with them in consequence. How confidently the members of the Geologists' Association may rely on Professor Blake's accuracy! Hyatt ("Genesis of the Arietidæ") gives an *involute* form like *lævigatus* as the ancestor of certain species; Buckman ("Monograph," p. 283) places an *involute* shell like *globosus* as the ancestor of the Polymorphidæ, and also (p. 289) states that the first stage of Ammonite ontogeny discloses a form like *globosus*, such, therefore, is the ancestral form he would seek.

In connection with the thickness (p. 28), Professor Blake announces a discovery which is new to us: "the whorls of an Ammonite become naturally more compressed with growth." What a number of unnatural Ammonites there must be! For instance: *Amm. bechii*, Sowerby; *spinatus*, Brug.; *sauzeanus*, d'Orbigny; *semicostatus* (Young), Hyatt; *adelæ*, d'Orbigny; *francisci* (Oppel), Vacek; *sutherlandæ*, d'Orbigny; *goliathus*, d'Orbigny; not to mention many others which change from less compressed to more compressed whorls, and again to less compressed in infancy or adolescence, and change again to more compressed in adolescence or maturity. We should have thought that the only law which could be laid down safely was that, in anagenesis, the whorls tend to become more than proportionally inflated, and, therefore, less compression is likely to arise; while in catagenesis the whorls tend to be less inflated, and greater compression may result. Unfortunately, the law is not so simple as this. Catagenesis may produce a less compressed whorl, because the reduction, in proportionate capacity, may be attained by reducing the breadth and not the thickness of the whorl.

The size of the Ammonite is given as one of the bases of classi-

fication! The size! We congratulate Professor Blake on this discovery. We believe it to be entirely his own, and entirely original, and we will not say a word to destroy the charming simplicity of the idea. Incidentally, we are treated to a most interesting piece of information about "*Ammonites planorbis*, now called *Psiloceras*"—"the fry are abundant, but the race was really gigantic, as may be seen by the specimen, over three feet in diameter, in the British Museum."

It would be strange if true; but, happily, this giant is not a specimen of "*Ammonites planorbis*, now called *Psiloceras*"; it is a senile example of *Ammonites conybearii*, now called *Vermiceras*, which not uncommonly attained the size of three feet across. It was not a contemporary of *planorbis* at all; but it lived much later, namely, in the time of *Pentacrinus tuberculatus*. That the label is incorrect in the British Museum implies no fault to anyone connected therewith. For one man to arrange the whole of the Cephalopoda—a subject which engages the attention of many specialists—is a too gigantic task; and accuracy in all cases cannot, therefore, be expected. That the public who take all the labels in the British Museum for gospel are thereby misled, is a pity; but while an overburdened museum-curator might successfully plead excuses for an incorrect label, no such plea can be allowed to such an authority on Cephalopoda as Professor Blake.

To illustrate the confusion which arises in the mind of the student —not the confusion which arises in his own mind on a subject about which he poses as a teacher—Professor Blake compares (p. 29) the generic grouping given by Buckman and by Futtlerer (*sic*), and remarks what "most observers" would do in such cases. How useful to appeal to "most observers"! "Most observers" would not make egregious mistakes in classification in any science. Does Professor Blake wish us to believe *vox populi vox Dei*; and does he forget that it was not only Carlyle who uttered a sentiment akin to *vox populi vox stultorum*? When the immortal Mr. Pickwick went to the election and shouted "Slumkey for ever!" he was asked, "Who is Slumkey?" He replied, "I don't know; it's always best on these occasions to do what the mob do." "But suppose there are two mobs," said Mr. Snodgrass. "Shout with the largest," said Mr. Pickwick. It will always be a case of the specialists against οι πολλοι. If Professor Blake wishes to emulate the immortal Mr. Pickwick, and shout with οι πολλοι, he is quite free to do so. It is to be hoped that when asked his reasons he will be equally candid, and reply "I don't know."

"Most observers," says Professor Blake, "would place the former (species put by Buckman into two genera) not only in the same genus, but almost in the same species, and the latter (Futterer's), not only in distinct genera, but in distinct families." We don't doubt it for a minute; and thereby the observers would show their profound

knowledge of ontogenetic and septal details in both cases! If a schoolboy were to class a whale as a fish, Professor Blake would be down on him for his ignorance; but the blunder in a schoolboy would be more excusable than are such remarks about Ammonites from Professor Blake.

We have given so much time to the criticisms of these various matters, that we cannot allude to numerous statements in this extraordinary paper; but we must not pass the cream of the whole article. "By comparing the figures [in the plate] . . . we seem to see how the *Stephanocerata* (pl. i., fig. 11) may have arisen from *Hammatoceras* (pl. i., fig. 10); and by comparing this with pl. ix., fig. 1, of Vacek's work almost from *Harpoceras*. In another direction we can pass towards *Perisphinctes* (pl. i., fig. 13), and in a third towards *Aspidoceras* (pl. i., fig. 12), and there is little to distinguish them in the outlines"! What skill and study must have been expended to construct such a complicated genealogy as this! We venture to say this effort has never been surpassed, not even by a would-be populariser of Science.

The *Stephanocerata* (pl. i., fig. 11)—an *inflated* shell with a spinous centre and costate outer whorl—"may have arisen from *Hammatoceras* (pl. i., fig. 10)" which is a *compressed*, wholly costate form, and has not the ghost of a spine about it, apparently; and this, "almost from *Harpoceras*" (Vacek, ix., 1) a *less* compressed fossil with a *smaller* umbilicus—evolute in youth but more involute with age! "In another direction we can pass towards *Perisphinctes* (pl. i., fig. 13)"—by a species which has remarkable and very distinct septa, namely, a peculiarly abbreviated siphonal lobe, and a lateral lobe specialised for a very particular purpose—features altogether unknown in *Perisphinctes*. "And in a third towards *Aspidoceras* (pl. i., fig. 12)"—except for septal details.

Of ontogeny Professor Blake takes not the smallest account. He writes a paper on the bases of the classification of Ammonites, and never so much as mentions ontogeny, except to admit the similarity of ontogeny to phylogeny as a guide in genealogy. Does Professor Blake know what these words mean? and has he applied to this genealogy a principle which he has utterly ignored in his paper? According to this genealogy, the facts of evolution are not given clearly enough nowadays; and we have always applied them the wrong way about. Obviously, we have to learn that the details of embryology show whither a species is going, and the details of senility which illustrate whence a species has come!

We are indeed grateful to Professor Blake and his genealogical table for giving us such information as this, and for showing us how to use it. We shall be able to correct the misapprehensions in regard to evolution under which we have hitherto laboured. For the future we can construct a genealogy like this:—Here is a monkey who grows less hairy in his old age—he shows how monkeys may have come

from man; here is a man who is losing his teeth in old age; he shows how man may have come "almost" from a whale. A fish and a whale are very much alike, "at least, there is little to distinguish them in the outlines"—in another direction, a whale may have developed into a fish. To anyone acquainted with Ammonites, remarks like these are every bit as intelligent as those of Professor Blake; but while their value can be gauged almost by boys in the schoolroom, the pity of it is that so few people are able to properly appreciate the remarks of the ex-President of the Geologists' Association.

One last sentence we will notice in this strange address. "The modern genera of Ammonites . . . do not range much beyond the ancient idea of species" (p. 38). Certainly, the following does not represent the modern idea of species. "The family of shells allied to this species is so very variable that there is no mean between naming every minute difference . . . and throwing them into groups. I have chosen the latter method, and unite all those which may be called inflated *S. commune* under the present name, and those that stand in the same relation to *S. annulatum* under the next. They seem to develope (*sic*) tubercles indiscriminately . . . , etc."—("Geology of Yorkshire (Cephalopoda)," p. 300.)

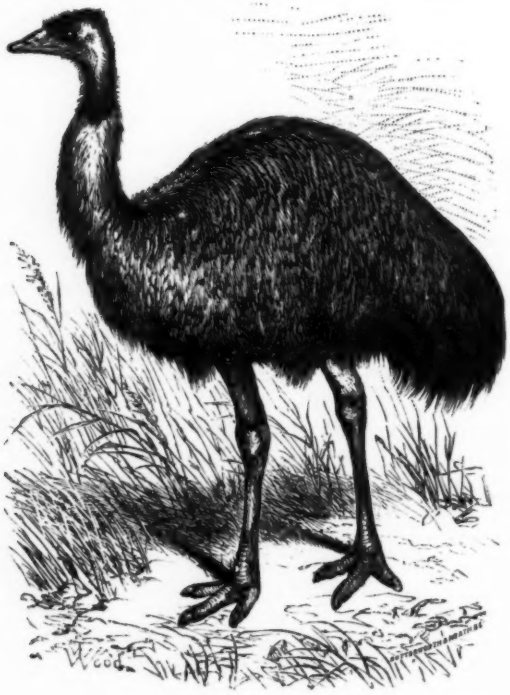
This, of course, is the ancient idea of species—date, 1874; but the old masters in Science had the merely paltry modern ideas concerning species—they actually did not "throw" forms into "groups," *vide* Sciences more ancient than Palæontology; and they took the trouble—even those who dealt with Ammonites—to observe differences in involution, costation, ornamentation, and septal details. It is a pity that they did; no doubt they would have saved themselves this trouble if they could have foreseen the "ancient idea of species."

In conclusion, then, we must express our conviction that an efficient paper on the Bases of the Classification of Ammonites yet remains to be written; and it will not be accomplished by a man who—whatever he may, at one time, have done among Cephalopods—has for some considerable time turned his attention to matters entirely different, and yet imagines that with a few weeks' study he can become master of the work of several years.

SOME NEW BOOKS.

A DICTIONARY OF BIRDS. By Alfred Newton, assisted by Hans Gadow, with Contributions from R. Lydekker, C. S. Roy, and R. W. Shufeldt. Part I. 8vo, illustrated. London: A. & C. Black, 1893. Price 7s. 6d. nett.

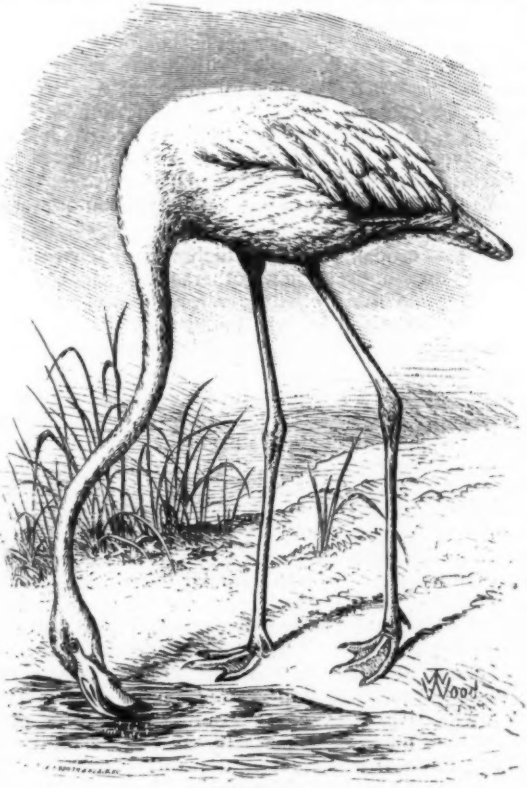
THE appearance of a general work on birds by an ornithologist of the long experience of Professor Newton may well be regarded as marking an epoch in the science of which it treats; and the foretaste afforded by the issue of this instalment leads us to believe that this opinion will not be belied when the whole volume is completed. Like certain



EMEU.

other zoological works issued by the same enterprising publishers, the manual before us is based upon a series of articles written by its author for the ninth edition of the "Encyclopædia Britannica"; but, we believe, the new matter is in this instance still greater than

in the case of the other works. The present work differs, moreover, essentially from the others of the same series in that, as indicated by its title, it is in dictionary form. In deciding to treat his subject from the alphabetical rather than from the taxonomic standpoint, the learned professor, to use his own words, says that this plan has been adopted "because I entertain grave doubt of the validity of any systematic arrangement as yet put forth, some of the later attempts being in my opinion among the most fallacious, and a great deal worse than those they are intended to supersede. That in a few directions an approach to improvement has been made is not to be



Flamingo.

denied; but how far that approach goes is uncertain. I only see that mistakes are easily made, and I have no wish to mislead others by an assertion of knowledge which I know no one to possess." These are strong words, and we are glad to see them coming from an ornithologist of the long standing and well-deserved reputation of Professor Newton; more especially since we have had occasion elsewhere in this Journal to raise our own feeble protest against the succession of crude and ill-matured schemes of avian classification with which the ornithological world is flooded. Admitting, then, the wisdom of the author's choice in selecting the alphabetical form,

we have no hesitation in saying that the plan and execution of the work are in every way worthy of the high reputation of its author; while the excellence of the illustrations, and the careful manner in which a complicated typography has been executed, reflect credit alike on author and publishers. In calling in the aid of such a master of avian anatomy and morphology as Dr. Gadow, for articles coming within his special province, the author shows that he does not pretend to omniscience even in his particular branch of zoology, and thus affords an example which might be followed with advantage by others. The other writers mentioned on the title-page have likewise contributed articles on certain branches of ornithology with which they are more especially acquainted; and, so far as this instalment permits of forming a judgment, the work thus seems as complete and authoritative as it could well be made. That its style, although necessarily condensed, is terse and elegant, all acquainted with the author's previous writings stand in no need of being informed; while its freedom from typographical errors affords a refreshing contrast to some works that have recently come under our notice. Indeed, we have hitherto detected but a single misprint (p. 281, line 2 from bottom), and that is the fault of one of his contributors rather than of the author himself.

Of the illustrations, two of which we are enabled to give as samples, some are entirely new, others are reduced from figures previously published, while others again have been borrowed directly from earlier ornithological writers; and we are glad to see Swainson's exquisite figures of beaks and heads once more brought prominently before the public.

In our limited space it would be impossible to give a detailed notice of any of the articles; and, indeed, if such space were available, we should be puzzled to know which to select for special commendation. We may mention, however, that each bird, or genus of birds, is generally described under its vernacular name—whether this be English or foreign—although cross references will be found under the scientific titles of the genera. Among the articles that have specially interested us, are those on the cassowary and emeu, which are admirable samples of what a brief semi-popular description of a bird and its habits should be; while the article headed "Extermination" cannot fail to arouse a general, if somewhat mournful, interest. We may, however, be permitted to ask the author why he states under the head of Emeu that this "is the only form of Ratite bird which naturally takes to the water, and examples have been seen voluntarily swimming a wide river." We do not for one moment venture to say that the statement may not be perfectly correct, but at the same time we should like to know what reason the author has for discrediting the following account of the habits of the Rhea (or Ostrich as it is there called) given in the "Voyage of the 'Beagle.'" Darwin there writes that "it is not generally known that ostriches take readily to the water. Mr. King informs me that at the Bay of San Blas and at Port Valdes, in Patagonia, he saw these birds swimming several times from island to island. They ran into the water both when driven down to a point, and likewise of their own accord when not frightened; the distance crossed was about two hundred yards. When swimming, very little of their bodies appear above water; their necks are extended a little forward, and their progress is slow. On two occasions I saw some ostriches swimming across the Santa Cruz river, where its course was about four hundred yards wide, and

the stream rapid." Surely the statement of two independent observers requires refutation before it is authoritatively asserted that emeus are the only Ratites that naturally take to the water.

R. L.

Dr. H. G. Bronn's Klassungen und Ordnungen des Thier-reichs.—Aves. By Hans Gadow, Ph.D. IV. Abtheilung. 42 u. 43 lieferung.

The anatomical portion of this most important work was completed some few months since, and we have now before us the first two numbers of the systematic part. Veritably they are children of promise, and, unless we are much mistaken, the sum of Dr. Gadow's labours will be two invaluable volumes, each the perfect complement of the other, beautifully symmetrical, nicely balanced.

In these two parts Dr. Gadow presents us with a pithy sketch, which practically embraces all that is worth knowing in the history of Systematic Ornithology. Beginning with an "Historical Survey," he tells us that only those systems have been noticed which have either advanced—or hindered—our knowledge, as well, also, those which, although possessing practically no influence to-day, yet are of interest, inasmuch as they serve by reflected light to illuminate preceding systems. This is surely a wise course, inasmuch as it will enable us to appreciate much that would otherwise of necessity have remained more or less obscure.

After briefly referring to the three great epochs in the history of avian classification, so ably demonstrated by Dr. Sharpe in his "Review of Recent Attempts to Classify Birds," the author has a few words to say anent the errors of yesterday, and the dangers of employing one particular character, after the fashion of patent medicines, to remedy all evils and solve all difficulties. Next follow some thirty-four examples of the most important systems of classification, beginning with that of Linnæus in 1735, and ending with Dr. Sharpe's in 1891. In every case we have appended a brief yet all-sufficient summary, giving the chief points of interest or importance. Of these the author has selected for special mention some dozen examples, Huxley, Garrod, Sclater, and Newton being amongst the number.

The classification of Linnæus is shown to have been based upon the work of our countrymen Willoughby and Ray, of whom we are justly proud. Be it noted that Dr. Gadow here awards them full credit for their labours, considering them the founders of "Systematic Ornithology." To Merrem belongs the honour of having founded the sub-classes Ratitæ and Carinatæ, which have received recognition in every system of importance up till now. Nitzsch, with his researches in the Carotias, Osteology and Pterylography, and Müller on the organ of voice in the Passeres, have placed us under an everlasting debt. With Huxley's classification, the author tells us, began a new epoch, and, indeed, his work is too well known to need comment here. To Garrod, Dr. Gadow points out, we owe much. The Homalogonatous and Anomalogonatous arrangement of the muscles of the leg, the Holorhinal and Schizorhinal condition of the nostrils, the patagial muscles of the wing, and the syringeal muscles, are all points upon which this indefatigable worker enriched our knowledge. Garrod attacked the vexed problems of Ornithological Classification with intense zeal and a very considerable amount of success, but, as we are remined, not entirely without error. Fürbringer's work is

warmly praised, and, as the author points out, no ornithologist can proceed far without consulting his ponderous tomes. Dr. Sharpe's work, previously referred to, is, we think, deservedly considered an "important production," as all who have occasion to dabble in the mysteries of the complicated subject will allow.

As before stated, Dr. Sharpe's work is the last on the list—to our surprise, for we expected to find at least a reference to a most suggestive, if only tentative, scheme by Dr. Gadow himself, which appeared in the *Proceedings* of the Zoological Society for March, 1892; although it is more than probable that this will not be adopted in its entirety in the present work, yet we venture to think it should have been included; doubtless, however, the author has good reasons for its omission.

We come now to what might be called a diary of remarkable events in Systematic Ornithology—a sort of developmental history of classification. This retrospect (Rückblick) is arranged in a more or less tabular form, and is designed to show the more important changes of position which birds of doubtful affinity have been subjected to. To take an example at haphazard we quote the following: "Müller, 1847, *Cypelhus* removed from the Oscines, and placed with *Caprimulgus*." (First) recognition of the order *Oscines* ("Klärung der Oscines"). Some twenty-nine more or less well-known workers are quoted in this connection, beginning with Mohring in 1752, ending with Fürbringer in 1888.

Under the next heading, "Taxonomical Outlines," the author deals with the general principles of Taxonomy, and discusses in turn genealogical trees, that phenomenally arbitrary system the "Key," and the various organs used by systematists as "Characters" wherewith to differentiate various groups. Finally, we have a very valuable table of "Characters" used in classification, which are expressed chiefly by signs, for the sake of brevity and clearness. Seeing that these signs are carefully described in the text immediately preceding, there should be no difficulty in assimilating them. We would suggest, however, that eventually they should be published in one large sheet for use separately.

Dr. Gadow is to be congratulated on the decided "hit" he has made, and we are sure that we do but echo the sentiments of other workers in this field when we say that we are anxiously looking forward to the appearance of parts 44 and 45. Nevertheless, we will try to keep in view that very useful proverb, "Eile mit weile,"—a motto which Dr. Gadow wisely adopts. W. P. P.

MANUAL OF BACTERIOLOGY FOR PRACTITIONERS AND STUDENTS. By Dr. S. L. Schenk, Professor in the University of Vienna. Translated (with an appendix) by W. R. Dawson, B.A., M.D. (Dublin). 8vo. Pp. 310. London: Longmans and Co., 1893. Price 10s. nett.

THIS, the most recent text-book in English upon the new science, appears to be well translated and to merit a longer notice than is sometimes allowed to translations; for Dr. Dawson has added a valuable and timely appendix upon the mode of vaccination for cholera, a disease which has already paid us a visit this year—a visit which was, fortunately, brief; he has also included an account of Professor Marshall Ward's interesting observations on the influence of light upon bacteria, which have only just been published in the *Proceedings* of the Royal Society.

The best way of coping with many pathogenic bacteria appears to be to let daylight in upon them; it has been stated that a few minutes of direct sunlight are enough to kill the deadly bacillus of consumption, and that even diffused daylight is fatal in a longer or shorter time according to its intensity. Unfortunately, this mode of treatment is hardly applicable when the bacilli have got into the body; but they might be lessened in numbers, and the danger of infection thus diminished, by thorough ventilation of suspected localities. An open drain is neither pleasant to the eye nor agreeable to another sense which largely comes into play where bacteria abound, but it is from many points of view more healthy than a close drain, where, hidden from the sun's rays, the fellest varieties of bacteria can multiply unchecked. For practical purposes, too, any mode of dealing with typhoid is very important; it is an exceedingly common disease, and there must be few people who have not lost some friend or relative by its means; the germs of this complaint are killed by sunlight of four to seven hours' duration.

To those who have not followed recent bacteriological work, some of the figures given in this book will be surprising. One knew ever so many years ago that the large spirilla had a flagellum at each end by which they moved; now it is known that most kinds—even some of the most minute—are provided with a bunch of these vibratile processes; and this accounts, perhaps, for the rapid progress through an organ, or a system, as the case may be, of some infectious complaint; the typhoid bacilli from the great number of flagella which spring here and there from the organism are called "spider cells." As is well known, many different kinds of bacilli—alike enough on a superficial inspection—can be distinguished by their different reaction to staining fluids; and this important means of detecting a given bacillus is impressed upon the mind of the student in the work before us by the use of differently coloured figures in the text. We have, indeed, nothing but praise for the illustrations, which are not only good but abundant.

The word "Bacteriology" is used in the book before us in a sense rather wider than that usually applied to it, and the author says something about other kinds of unicellular parasites. There is a growing tendency to ascribe cancer to a Gregarine; and the important researches of Drs. Rüffer and Walker are justly quoted (by the translator) in this connection—researches which have since been confirmed upon the Continent. Gregarines are such abundant parasites in the lower animals (insects, earthworms, etc.), where their existence appears to be attended with such slight inconvenience to their hosts, that it is, perhaps, remarkable how extremely dangerous they are in the form of cancer in the human species. F. E. B.

ON ENGLISH LAGOONS: Being an Account of the Voyage of Two Amateur Wherrymen on the Norfolk and Suffolk Rivers and Broads. By. P. H. Emerson. 8vo. Pp. 298. London: David Nutt, 1893. Price 7s. 6d.

WE took up this volume with a feeling by no means favourable to the author, for of late years we have been overwhelmed with books on the Norfolk Broads. Mr. Emerson, however, has a far better claim than most to write on the subject, for he has lived the whole year round on the broads, and can describe them as they appear in a

severe winter as well as during the ordinary season for visitors. One fault only we have to find. His pictures of the broads, though striking enough to those who already know the district, will often scarcely be intelligible to strangers, for he has a habit of leaving out essential parts of the description—parts so familiar to the author and to the natives that they have ceased to be remembered.

Mr. Emerson is a good field naturalist, and his book is full of interesting notes on the habits of the birds, though there is nothing strikingly novel. Among the notes on the fish, there is a very curious one on a large take of eels at Geldeston Lock in December, after a very severe frost, and with the river full of ice and snow. As eels usually hybernate in winter, this was most unexpected, and we are glad that a naturalist like Mr. Emerson was on the spot and can vouch for the fact. Can this sudden appearance of eels have been connected with the formation of anchor ice, which disturbed the eels in the muddy bottom in which they had been lying? The formation of anchor ice is not a common phenomenon in Norfolk; but the severe frost with clear sky which the author recorded a few days before ought to have caused its appearance. Mr. Emerson makes also a good many remarks on the manners and customs of the natives. He seems, however, to be much more able to appreciate the good points of a fish or of a bird than of a human being; our own experience has not led us to consider the Norfolk people so utterly boorish as he pictures them.

Manuel de Géographie Botanique. Par Oscar Drude, traduit par Georges Poirault et revu et augmenté par l'auteur. Livraison I. Paris: P. Klincksieck, 1893. Price fr. 1.25.

There are so many who find French easier reading than German that a translation in the former language of Drude's important book will be very generally welcomed. The value of the present work is, moreover, enhanced by the fact that it is reviewed and augmented by the author so that it should be in every way up to date, a matter of importance when dealing with geographical distribution, a subject in which new series of observations on plant biology, or the better understanding of the flora of a region and its relations to neighbouring ones, may necessitate a reconsideration of hitherto accepted theories.

According to the advertisement, the complete work will form a volume of about 500 pages (8vo), and will include 4 coloured maps and 3 figures in the text. It will be published in 12 or 13 parts, each containing two or three sheets of text. We are glad to note that the parts will follow each other rapidly. The price of each part is 1 fr. 25, the subscription to the complete work, payable in advance, 15 francs.

Part I. contains 48 pages, and is clearly printed on good paper. It comprises an introductory definition of the subject, with a brief account of its relation to geology and physical geography, and also a portion of the first part of the book dealing with the influence of external agents on the plant organism. Under geographical agents are considered the influence of duration and intensity of light, of heat, cold and dryness; acclimatisation is briefly disposed of, and a section on phenology follows. Next, under topographical agents, the influence of the soil is discussed. We shall await with interest the succeeding parts of what promises to be a valuable work.

THE GENUS MASDEVALLIA. Issued by the Marquess of Lothian. Plates and descriptions by Miss Florence H. Woolward. Part IV. London: R. H. Porter, 1893. Price £1 10s.

MASDEVALLIAS form a favourite genus with orchid growers, and are, besides, of great interest from a botanical point of view. They are confined to tropical America, inhabiting chiefly the damp higher regions of the Andes, but ranging up into Central America and southwards as far as Rio Janeiro. Though, speaking systematically, a good genus, it includes species widely different in appearance. Contrast, for instance, the brilliant *Masdevallia Harryana*, one of the most common in cultivation, with its broad-spreading perianth limbs, with the more sombre-coloured *M. coriacea* and it allies, where the perianth takes the form of an open fleshy cup; or, on the other hand, with the gorgeous *M. bella*, where the lip, no longer inconspicuous or hid within the tube, forms in its shell-like beauty a striking characteristic of the flower. The range of colour is as wide as that of form. Now a plain scarlet or orange, or, alas! even magenta, an almost pure yellow, or, but rarely, white; now, on the other hand, a rich blending of citron and crimson lake as a background to the pure white lip. To all of these Miss Woolward does ample justice in the beautiful plates which accompany and interpret the descriptions of every species.

Much of the material for the work is from Lord Lothian's own collection of orchids at Newbattle Abbey; but Miss Woolward has also had the advantage of specimens, both living and dried, from orchid growers and in herbaria, for purposes of comparison and description. The carefully-drawn floral dissections on each plate will be invaluable to the botanist. Consul Lehmann (German Consul in the Republic of Colombia) has supplied interesting notes on the habitat of those species with which he is acquainted in their native homes. The present number also includes a species from Brazil, which has not yet reached Europe, but drawings and descriptions of which have been supplied by Professor Rodriguez, the Director of the Gardens at Rio Janeiro. In the same issue a new species is described, a striking plant near *M. elephanticeps*, and apparently imported by Mr. Bull mixed with the latter plant, as it was purchased from him under that name.

Part IV., like its three predecessors, contains ten species, bringing the whole number up to forty, and we understand that Part V. is well on the way.

ILLUSTRATIONS OF THE TYPICAL SPECIMENS OF LEPIDOPTERA HETEROCERA IN THE COLLECTION OF THE BRITISH MUSEUM. Part IX. The Macrolepidoptera Heterocera of Ceylon. By George Francis Hampson. 4to. Pp. vi., 182, pls. clvii.–clxxvi. London: Published by the Trustees of the British Museum, 1893.

THIS ninth part of the British Museum Catalogue is devoted to the Macrolepidoptera Heterocera of Ceylon, and consists of a "General Systematic List," followed by "descriptions of species figured," containing a formidable number of new genera. There is an interesting illustration of protective mimicry shown by the caterpillar of *Cornibœna biplagiata*, in which the sides of each somite are produced into fleshy processes, upon which the larva fastens small pieces of withered leaves and sticks as a disguise. It may be as well to mention that this information occurs on p. 145, for as is usual in this series of volumes there is no index, and one has to hunt through page after page of text to find the details required.

NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

Miss Maria M. Ogilvie, B.Sc., well-known for her researches in the geology of the Tyrolese Alps, has been promoted to the degree of D.Sc. in the University of London.

Dr. William H. Howell, of the Harvard Medical School, has been appointed Professor of Physiology in Johns Hopkins University; and the vacant chair of Anatomy in the same University has been accepted by Dr. Franklin P. Mall, late of Chicago.

Dr. Spyridon Miliarakis, curator at the Athens Botanical Museum, has been appointed Professor of Botany at the University; and Dr. Ed. Fischer has been appointed extraordinary Professor of Botany at the University of Berne.

Dr. U. Dammer and Dr. P. Hennings have been appointed assistant-curator and curator respectively in the Berlin Botanic Garden, and Dr. M. Gurke a curator in the Botanic Museum.

Mr. F. W. Gamble, B.Sc., has been appointed Assistant Lecturer and Demonstrator of Zoology in the Owens College, Manchester. Mr. H. B. Pollard, M.A. (Oxon), has been elected to a Berkeley Research Fellowship in Zoology in the same College.

Dr. Giessler, assistant at the Botanical Institute of the Jena University, has been appointed assistant at the Botanical Museum and Garden of the Göttingen University in the place of Dr. Hallier, who, as noticed in a former number of Natural Science, has become an assistant at the Buitenzorg Garden in Java. At the same University (Göttingen), Dr. Dreyer, from St. Galle, takes the place of Dr. Alfred Koch as assistant in the Institute of Plant Physiology.

We regret to announce the retirement, on account of failing health, of Sir J. William Dawson from the Principalship of McGill College, Montreal, an office he has held for nearly forty years. While relieved of administrative duties, Sir William hopes to be able to pursue with greater success his long-continued researches in geology and palæontology.

The Royal Saxon Mining Academy in Freiberg has had attached to it since 1767 a "Mineralien-Niederlage," or commercial branch for the supply of specimens. This is situated in the main building of the academy, and as a public office has been under the supervision of the director. We have received what is to be the first price list issued, written in remarkably good English, and showing that the mineral productions of Saxony can be supplied at most reasonable terms. Both A. G. Werner and A. Breithaupt have been the managers of this concern. Special stress is laid on the necessity of addressing letters Freiberg, Saxony.

THE Essex County Council Technical Instruction Committee has issued a prospectus of lectures and classes in Chemistry and Biology. The course of instruction is graduated in an interesting manner, there being first "pioneer lectures" on subjects of every-day life, then short introductory series of a popular character, and subsequently systematic and practical courses. There are also "County Normal Classes" for the instruction of advanced students as teachers. Mr. David Houston is Staff-Instructor of Biology, with Mr. Wilfred Mark Webb as Demonstrator. Mr. J. T. Cunningham, of the Marine Biological Laboratory, Plymouth, has also arranged to commence lectures in October on the Natural History of marketable sea-fishes and oysters.

WE have received the first part of vol. iii. (new series) of the *Journal of the Marine Biological Association of the United Kingdom*. In the report of the Director, Mr. Edward G. Bles, reference is made to a change in the regulations by which the shortest term for the renting of a table at the Plymouth Laboratory is reduced from one month to one week. This should induce investigators to take any opportunity which may occur at any time of the year to collect seasonable material, or to study living animals and plants available for the time being. Among the papers there are two important contributions to the fauna of the English Channel, one on Nemertines, by T. H. Riches, and another on Turbellarians, by F. W. Gamble. Mr. J. T. Cunningham discusses the "Immature Fish Question," and the colouration of the skin in flat-fishes. Dr. W. B. Benham gives a beautifully illustrated description of the post-larval stage of *Arenicola marina*; and there are two reports of economic interest by E. W. L. Holt and W. L. Calderwood.

THE annual report of the American Museum of Natural History, New York, for 1892, has lately been issued. The opening of the Museum on Sunday afternoons appears to have proved a success; and the popular lectures, arranged with the aid of the professors of Columbia College, are highly appreciated by the public.

THE Department of Botany of the British Museum has purchased the great collection of Diatoms made by Mr. Julien Deby, estimated to consist of about 30,000 slides. Although the Museum previously possessed a magnificent series, including Greville's, William Smith's, Gregory's, O'Meara's, Ralf's collections, etc., there is singularly little duplicate material in the Deby Collection, which was, before acquisition, the only rival of the Museum collection in importance. It has been handed over in excellent order, fully indexed and accessible to students.

THE annual meeting of the Palæontographical Society was held on June 23, when a satisfactory report of progress was presented. Only two non-members of Council, however, attended. The Right Hon. Professor Huxley was elected President in succession to the late Sir Richard Owen.

THE question of the admission of Women as Fellows was decided in the negative by the Royal Geographical Society, at a special general meeting held on July 3. The voting was 172 against, 158 for. The result is disappointing, but is what might have been expected under the circumstances.

NEXT year the Geological Society of London publishes the fiftieth volume of its Quarterly Journal. It has been decided to mark the event by preparing an index to the whole series, which will probably be published early in 1895.

The First Report of the Scientific Society of University College of Wales, for session 1892–93, has just appeared. It is a modest little pamphlet of 12 pp. and contains besides business matters a tentative list of the Flora and Fauna of the district around Aberystwith. Since the formation of the Society, Oct. 20, 1892, the members have made eight excursions, chiefly to places of geological interest, their enthusiasm even taking them afield in November and December.

The thirteenth report of the Manchester Microscopical Society is prefaced by an excellent portrait of the President, Professor Milnes Marshall. There are two readable presidential addresses, the one on "Death," the other on "Recent Embryological Investigations"; and Professor Weiss briefly discusses Symbiosis in plants, Mr. P. Cameron contributes part ii. of his description of the galls of Mid-Cheshire. with two plates; and Messrs. W. Moss and F. Paulden give an illustrated account of the reproductive organs of *Bulimus acutus*.

The Guernsey Society of Natural Science and Local Research has completed the first decade of its existence, and the new part of its *Report and Transactions* contains several valuable papers. Mr. E. D. Marquand supplements his list of the flowering plants of Guernsey by an account of the mosses, hepaticæ, and lichens, and it is noteworthy how many species common in Devon and Cornwall appear to be absent in this island. Mr. W. A. Luff publishes a list of the Hemiptera-Homoptera, the first of the kind relating to any of the Channel Islands. Mr. G. Derrick describes the Guernsey clays, and in another geological paper Mr. A. Collenette considers that the raised beaches and associated phenomena prove Guernsey to have been completely submerged at a recent period. A brief account of the rocks of Alderney is also given by Mr. C. G. De La Mare.

Circulars dated June 10 inform us that "The World's Congress of Geologists will meet in Chicago" immediately after the meeting of the American Association in Madison. The Geological Society of America will also hold its fifth summer meeting on the 15th and 16th of August at Madison. The Excursions proposed for the Geological Society of America will comprise the Lake Superior Region, the Dells of the Wisconsin, and the driftless area in the vicinity of Madison. Messrs. Wadsworth, Van Hise, Chamberlin, and Salisbury will conduct the Excursions.

The Geologists' Association of London called a Special General Meeting on July 7 and passed some important alterations in the rules. It was decided that the names of those proposed as members should, after being read out from the chair, be declared duly elected unless a ballot was demanded. It is hoped by this means to avoid much unpleasantness and expenditure of time, while opportunity is afforded of an appeal to the ballot, if any one of those proposed for election is considered ineligible. 'Another important change is the increase of the commutation fee or life subscription to seven pounds ten shillings, being fifteen years' purchase. This is in accordance with the practice of other Societies, it having been found that the low commutation fee has been a loss to the Association for several years past. The third important change is an expulsion clause. We trust the Association has not been compelled to adopt this in self-defence, but rather as a terror to possible evil-doers. The clause appears to us to be very cautiously worded, and will no doubt prove valuable if required. Ugly as these clauses are, they are necessary for the general welfare of the members.

The 42nd meeting of the American Association for the Advancement of Science will be held in August at Madison, Wisconsin, under the presidency of William Harkness. The president of the Geological Section will be Mr. C. D. Walcott,

who discourses on "Geologic time as indicated by the Sedimentary Rocks of North America"; of the Zoological Section, Professor H. F. Osborn, whose address is to be devoted to "The Rise of the Mammalia"; of Botany, Professor C. E. Bessey, who speaks on "Evolution and Classification." Dr. J. O. Dorsey, the president of the Anthropological Section, will read a paper on "The Biloxi Indians of Louisiana."

THE next Congress of the French Association for the Advancement of Science will be held at Besançon from August 3 to 10. M. A. Magnin, professor at the Besançon Faculté des Sciences, will preside over the botanical section, and he suggests as a subject for discussion the question, already touched on, but in an incomplete manner, of the formation and conservation of botanical collections, also the relations of the Jura flora to the vegetation of the Alps.

THE Selborne Society celebrated the centenary of the death of Gilbert White, June 26, by a visit to the Hampshire village, immortalised as the scene of the unassuming naturalist's labours. Gilbert's father was squire of Selborne at the time of his son's birth in 1720. Gilbert, the eldest of several sons, went to Oxford, where he graduated in 1744, gaining a Fellowship at Oriel. He lived some time at the University, serving for a year as Senior Proctor. In 1753 he took a curacy, but two years later we find him at his father's house at Selborne, where he stayed till 1758, when his father died. He then did duty in Faringdon, a neighbouring parish, returning in 1784 to Selborne, where he remained as curate till his death in 1793. The "Natural History of Selborne" appeared in 1789, only four years before his death.

WE have received some circulars from Mr. Joseph Coe, of 33 All Saints' Street, Hull, from which we learn that an excursion was conducted on June 12, 1893, to Mablethorpe, by some of the more energetic naturalists of Lincolnshire, for the double purpose of investigating the natural history and geology of the district, and considering the question of founding a "Lincolnshire Naturalists' Union." Professor Miall, Rev. Canon Fowler, Messrs. F. M. Burton, Denison Roebuck, John Cordeaux, and others were present, Professor Miall taking the chair; a favourable decision was obtained, and those present at the excursion were formed into a temporary committee to draw up rules and elect officers at Lincoln on July 1. At the meeting of this committee the necessary formalities were proceeded with, and the first officers elected. Mr. Cordeaux is to be the first President; Messrs. W. F. Baber and Joseph Coe, Honorary Secretaries; while the sectional presidents are Mr. G. H. Caton-Haigh (Vertebrate Zoology); Rev. C. W. Whistler (Conchology); Rev. Canon Fowler (Entomology); Rev. W. Fowler (Botany); Mr. F. M. Burton (Geology) Mr. R. J. Ward (Micro-zoology and Micro-botany). Field meetings will be held twice a year, once in the northern and once in the southern division of the county; the subscription is 5s., but those subscribing 10s. 6d. will receive the proposed publications of the society.

THE Museums' Association, which formed the subject of our first comment last month, met, by permission of the Zoological Society, at 3 Hanover Square on July 3. The retiring President, Professor Boyd Dawkins, was unavoidably absent, and the chair was taken by the new President, Professor Sir William Flower, who delivered an opening address. On Tuesday, July 4, Dr. Jonathan Hutchinson opened the proceedings by a paper on "Educational Museums," which was followed by an interesting discussion. Mr. Ruskin's views on Museums were expounded by Mr. W. White, and Mr. Newstead read some notes "On the use of Boric Acid as a preservative for Bird-skins." Visits were paid in the afternoon to the Natural History Museum, and the South Kensington Museum. On the Wednesday, Dr. Sclater discoursed "On the Typical Forms of Vertebrated Animals suitable for Exhibition,"

Mr. Platnauer "On the Arrangement of Insect Collections in Museums," and Mr. Newstead "On the Preparation of Coccidæ for Museums." The day concluded with a visit to the British Museum, and a Conversazione at the Royal College of Surgeons. The Royal Wedding on Thursday fortunately provided an excuse for open-air work, and the members visited the Zoological Gardens and Sir John Soane's Museum. Thursday and Friday were devoted to exhibitions of museum appliances, or visits to various smaller private collections, while Saturday was agreeably spent by a visit to Dr. Hutchinson's private museum at Haslemere, and a ramble over the Hind Head district.

The papers read at the meetings will be printed later on, but Sir William Flower's address is already to be found in *Nature* (July 6 and 13). He again emphasised the absurdity of the crowding of specimens, pointed out the value of good labelling, isolation of objects, suitable backgrounds, and necessity of space, and referred to the insignificant amount expended by Government on the development of museums; he also referred to the contemptible offers which had lately appeared in the newspapers for curators of local museums—a subject mentioned in our comments last month. After speaking on the general theory of museum arrangement, Sir William Flower gave a sketch of the museums at the Jardin des Plantes, Paris, at Vienna, and at Berlin, and noticed "the most original and theoretically perfect plan for a museum," explained to the British Association by General Pitt-Rivers in 1888, finally presenting a plan of his own, which contemplates a one-storied, top-lighted building, in which the front galleries would be devoted to the public exhibitions, a second series of galleries would contain the reserve collections, while a third set of rooms would be occupied by the officers and students. In such a place as this the absurdity of having to walk a quarter of a mile and climb several staircases to compare a fossil plant with a recent plant, or a mammoth with an elephant, as one has now to do in the British Museum (Natural History), could not exist, and the officer in charge would be in direct communication with his reserve and exhibited series, instead of being, as in many cases, far removed. Another point brought out in this plan is the necessity for a lecture theatre, and an arrangement in construction of the officers' workrooms by which isolation from the main building is effected so as to permit those who desire to do so to remain for work instead of having to leave at an appointed hour. We hope to hear more of this plan, for many students would heartily welcome some radical changes in the present arrangement and working facilities of most public museums.

OBITUARY.

FRANCIS POLKINGHORNE PASCOE.

BORN SEPTEMBER 1, 1813 — DIED JUNE 20, 1893.

A VETERAN naturalist, well-known for his researches in Entomology, has passed away in the person of Mr. F. P. Pascoe. Born at Penzance eighty years ago, Mr. Pascoe was trained for the medical profession, and was always imbued with a taste for Natural History and travel. In 1835 he became M.R.C.S., and shortly afterwards entered the Navy as assistant surgeon, visiting Australia, New Zealand, the West Indies and the Mediterranean. In 1843 he retired from the service, married, and resided in Cornwall until the death of his wife in 1851. Subsequently Mr. Pascoe removed to London, when he gradually formed the great entomological collection now being acquired by the trustees of the British Museum. His first original paper related to a botanical subject, but all subsequent contributions dealt with his chosen field of research in Entomology, certain groups of Coleoptera. The results of his studies are to be found in the publications of the Linnean and Entomological Societies, and in numerous scientific journals, during the last thirty or forty years. His monographs of the Malayan and Australian longicorn beetles, in which the collections of Dr. A. R. Wallace are described, are among the most important of these. Although a believer in evolution, he was, with so many of the older systematists, opposed to the theory of Natural Selection. Two books, the latter of which appeared only three years ago, were written by him attacking the Darwinian position.

HENRY HUGH HIGGINS.

BORN JANUARY 28, 1815.—DIED JULY 2, 1893.

THE REV. H. H. HIGGINS, whose death is chronicled by the daily Press as having occurred while writing a paper for the Museums Association Meeting, recently held in London, was born at Turvey Abbey, Bedfordshire. Entering Corpus Christi College, Cambridge, in 1833, he obtained his B.A. in 1836, was admitted to Priest's Orders in 1839, and became a curate at Wolverhampton and at Shrewsbury. In 1842 Mr. Higgins went to Liverpool, and it is in connection with the Liverpool Free Museum that his name has

become famous. He was chairman of the Museum sub-committee of management for many years, and devoted much of his time to the arrangement of the collection. Mr. Higgins was the author of "Notes of a Field Naturalist in the Western Tropics," 1877, a "Synopsis of the Invertebrata," "Museums Memorandum Book," "Museum Talk," and several other pamphlets of a practical value on similar subjects. In 1880 he rendered special service to the Liverpool Museum by securing the duplicate Cirripedes collected by Darwin during the voyage of the "Beagle." He founded the Liverpool Naturalists' Field Club in 1860, and had been president of the Literary and Philosophical and the Microscopical Societies of Liverpool. The fine series of Coal-measure fossils from the railway cutting at Ravenhead near St. Helen's, now in the Liverpool Museum, was collected by himself. An excellent portrait of Mr. Higgins appeared in *Research* for July 1, 1888, and to the article which accompanied it, by Mr. O. W. Jeffs, we are indebted for most of this information.

THE death is announced of Dr. Henri Viallanes, Director of the Zoological Station of Arcachon. Dr. Viallanes, who was only thirty-six years of age, had paid considerable attention to the nervous system of the Arthropoda, and his early loss is much to be deplored.

WE also regret to record the death of Dr. John Rae, the Arctic explorer, and of Mr. James W. Davis, the geologist and archæologist, one of our valued contributors. Obituary notices will appear next month.

TO CORRESPONDENTS.

All communications for the Editor *to be addressed to the* Editorial Offices, *now removed to* 5 John Street, Bedford Row, London, W.C.

All communications for the Publishers *to be addressed to* Macmillan & Co., 29 *Bedford Street, Strand, London, W.C.*

All Advertisements *to be forwarded to the sole agents,* John Haddon & Co., *Bouverie House, Salisbury Square, Fleet Street, London, E.C.*

ADDENDUM.

On p. 59, line 38, after the words "Dr. Nansen on glaciation" add the words "are unsound."